3305
SoU

VOL. 1 NO. 3.

UNION OF SOUTH AFRICA

UNIVERSITY OF ILLINOIS LIBRARY
JUL 19 19

THE SOUTH AFRICAN JOURNAL OF INDUSTRIES

NOVEMBER, 1917

Issued by authority of the Hon. F. S. Malan, Minister of Mines and Industries

PRINCIPAL CONTENTS

(For List of Contents in detail, see page v)

	Page
Association of Chambers of Commerce	184
Results of Industries Census	191
Hibiscus cannabinus Fibre	198
Electro-Chemical Industries	209
Dominions Royal Commission	238
Asbestos	251
Possibilities of Paper Manufacture	271
Notes	173

PRETORIA
The Government Printing and Stationery Office
1917

UNION OF SOUTH AFRICA.

5 % LOCAL REGISTERED STOCK, 1921-1936.

SECOND ISSUE.

INTEREST EXEMPT FROM UNION INCOME AND SUPER TAXES AND EXCESS PROFITS DUTY.

The Minister of Finance offers the above Stock for subscription to an amount not exceeding the sum of £5,500,000. The subscription lists will be opened on 19th November, 1917, and will be closed on 15th December, 1917, unless the issue has been fully subscribed by an earlier date.

FIXED PRICE OF ISSUE, £100 per centum.

PERIOD OF LOAN.—Principal repayable at par on 30th November, 1936, but the Government has the option to repay at par on or after 30th November, 1921, after six months' notice.

INTEREST at the rate of five per cent. per annum, payable 30th November and 31st May. First payment of Interest will be made on 31st May, 1918, and will represent interest on instalments from date of receipt.

APPLICATIONS must be for not less then TEN POUNDS, and may be for multiples of TEN POUNDS in excess of that amount.

PAYMENT.—Five per cent., or more, on application, and the balance on or before the 30th April, 1918, in one or more instalments and on such date or dates as the subscriber may elect.

UNION TREASURY BILLS are convertible into stock of this issue.

CONVERSION RIGHTS.—Stock of this issue will be convertible at par into the stock of any future local issue.

TRANSFERS of the Stock, free of stamp duty, will be effected by deed registered in the books of the Treasury at Pretoria.

STOCK EXCHANGE QUOTATION.—Application will be made in due course for the listing of this issue on the principal stock exchanges in the Union.

THE PROSPECTUS, together with form of application, giving fuller information will be obtainable on the 12th November, 1917, from any bank, Civil Commissioner, Receiver of Revenue, or Money Order and Savings Bank Office within the Union, and from the Treasury, Pretoria.

COMMISSION of 5s. per cent. will be paid to banks, brokers, and recognized financial agents in respect of applications (not involving conversion of Treasury Bills) made through them.

MOSSOP & SON, LTD.

ESTABLISHED 1846.

Contractors to Imperial and Union Governments, Capetown and Johannesburg Municipalities, etc.

NOTE.—We are not Manufacturers of Boots, Shoes, or Harness.
Special quotations to Boot and Shoe Manufacturers, and Wholesale Buyers.

The largest and most up-to-date Tannery in South Africa.

Manufacturers of—

Sole Leather. In Sides, Bends, Backs, Shoulders, Squares, and Bellies.
Oak Tanned Sole Bends. For best Repair Work.
Harness Leather. Saffron, Black and London Colour. In Sides, Backs, Rein Backs, Bridle Backs, Strap Backs and Sides, Stirrup Butts, Skirt Shoulders or Butts (Pigskin Grain), Legging Leather and Baghide.
Harness Alum Leather. Sides or Backs, White or Brown.
Sole Alum Sides.
Kips. Saffron, Nut Brown, Chocolate, Black Pebble, Black Satin, Buffed, Russet, Army and Black Waxed.
Split. Black and Russet.
Chrome Sole Bends and Squares, Waterproof Chrome Sole Bends and Squares.
Chrome Upper Leathers. Glacé Kid Black, Boxhide, Willowhide. In Tan, Ox Blood, Nut Brown, and Chocolate.
Pump Leather Bends.
Hydraulic Bends. For Cup, Hat or Ram Leathers.
Hose Leather Backs.
Goat Skins. Saffron, Chocolate, Black Pebble, Russet, Buffed, Satin and Russet (Pigskin Grain).
Chair and Belt Laces.

Our Trade Mark is a guarantee of Reliable and Unadulterated Leather.

Liesbeek Tannery, RONDEBOSCH, Near CAPETOWN.

13—2-3-4-5-6-7

VERDITE MINES,

LIMITED.

Offices and Showrooms { Stock Exchange, Johannesburg.

P.O. Box 3383.

French Chalk.
Talcum Powder.

Engineers' and Boilermakers' Pencils.

"Verdite" Anti-Corrosive and Fireproof Paint.

"Klenum" for cleaning White Boots, etc.

"Verdite" Cloth Balls for cleaning Cloth, White Hats, etc.

"Verdite" Metal Polish.

"Verdite" Greenstone Ornaments and Jewellery, and for building decoration.

14—3

P.O. Box 736. TELEGRAMS: "REPAIRS," DURBAN.

Naval Construction Works,

Marine and General Engineers,

The Avenue, Point, Durban.

Tanks, Chimneys, Forgings, Drop Forgings, Links, Washers, and Pins for Coal Washing Plant.

Castings in Brass and Iron. Repetition work in Mild Steel or Brass.

New Machinery Built to specification, plan, or sample.

Phones: Office, 2264; Manager, 3119; Foreman, 2994; Manager's Residence, 2196.

5—1-2-3-4-5-6

W. F. JOHNSTONE & CO., LTD.,

TIMBER MERCHANTS,

Manufacturers of Windows, Doors, and all Classes of Joinery,

306 Smith Street, Durban.

Also at Johannesburg and Maritzburg.

8—1-2-3-4-5-6

"The Industrial Facilities and Advantages of Port Elizabeth."

Every Manufacturer or prospective Manufacturer should send for a copy of the Brochure dealing with the manifold facilities and advantages of Port Elizabeth as an Industrial Centre. Brochure posted free to applicants who are interested.

Port Elizabeth is the cleanest and most centrally situated port: abundance of Power, Light, Land, Water, and Labour. Municipality prepared to offer every facility and encouragement to suitable firms.

ADDRESS INQUIRIES:—

The Manager, Electricity and Industries Dept.,

P.O. Box 369, City Hall, Port Elizabeth.

11—3

"THE SOUTH AFRICAN JOURNAL OF INDUSTRIES."

The Industries Section of the Department of Mines and Industries is issuing a monthly publication under the above-mentioned title, to be devoted chiefly to matters concerning the industrial development of the Union. The journal will also serve as the official medium for the reports on the natural resources of South Africa which are being prepared at the instance of the Scientific and Technical Committee.

Subscription to the journal, which is published in English and Dutch separately, will be 5s. per annum, post free within the Union, payable in advance; single copies 6d. each.

THE GOVERNMENT PRINTER,
BOX 373,
PRETORIA.

Please enter my name as a subscriber to the "Journal of Industries," for which I enclose.....

Name.....

Address.....

.....

.....

English or Dutch. Please write distinctly.

JUST PUBLISHED.

DEPARTMENT OF MINES AND INDUSTRIES.

ANNUAL REPORT

OF THE

GOVERNMENT MINING ENGINEER

For the Calender Year ended 31st December, 1916.

PRICE 10s. 6d. (Post Free within the Union).

Obtainable from Government Printing and Stationery Offices at Pretoria and Capetown.

CONTENTS.

VOL. I. No. 3.

	PAGE
NOTES	173
CHAMBERS OF COMMERCE	184
THE CENSUS OF INDUSTRIES	191
CHLORIDE OF LIME	197
SOUTH AFRICAN FIBRE PLANTS	198
ELECTRO-CHEMICAL INDUSTRIES	209
DOMINIONS ROYAL COMMISSION	238
REPORT ON CERTAIN MINERALS USED IN THE ARTS AND INDUSTRIES ...	251
PAPER-MAKING IN THE UNION	271
THE LABOUR SITUATION IN OCTOBER	278
MINING LABOUR STATISTICS	281
THE UNION'S BLACK LIST	282
OUTPUT OF THE MINES	284

NOTICES.

The *Journal* is issued on or about the 15th of each month.

Subscriptions to the *Journal* are 5s. per annum, post free in the Union, payable in advance, or 6d. per copy.

Inquiries as to advertisement rates and subscriptions should be addressed to the Government Printer, Pretoria.

All other communications respecting the *Journal* should be addressed to the Acting Editor.

Correspondence and contributions on industrial and allied subjects are invited, and, if suitable, will be published, so far as the exigencies of space allow.

The Government does not accept responsibility for the statements and views contained in articles or letters appearing under the author's signature.

Any of the contents of this Journal may be reproduced in any registered or public periodical without special permission, provided that the source is acknowledged in each case.

The constitution of the bodies which have been appointed to work in association with the Industries Section of the Department of Mines and Industries is as follows:—

INDUSTRIES ADVISORY BOARD.

Mr. C. G. Smith, Chairman.

Sir. T. Cullinan.	Mr. W. R. Jackson.	Mr. F. T. Nicholson.
Mr. E. Chappell.	Mr. G. A. Kolbe.	Mr. J. Pyott.
Mr. A. J. Chiappini.	Mr. W. J. Laite.	Prof. G. H. Stanley.

A. Canham, Secretary, Department of Mines and Industries, Pretoria.

SCIENTIFIC AND TECHNICAL COMMITTEE.

Mr. Bernard Price, Chairman.

Prof. J. C. Beattie.	Mr. L. Colquhoun.	Dr. L. Peringuey.
Mr. J. Burtt-Davy.	Prof. D. F. du T. Malherbe.	Prof. B. de St. J. van der Riet.
Dr. W. A. Caldecott.	Prof. J. Orr.	Prof. R. B. Young.

Secretary, Room No. 18, New Law Courts, Johannesburg.

EDITORIAL COMMITTEE.

Prof. R. B. Young, Chairman.

Mr. E. Chappell. Mr. J. Burtt-Davy.

"SOUTH AFRICAN JOURNAL OF INDUSTRIES."

Acting Editor: A. Canham,

Industries Section, Department of Mines and Industries, Pretoria.

H. WARINGTON SMYTH,

Secretary for Mines and Industries.

Digitized by the Internet Archive
in 2025 with funding from
University of Illinois Urbana-Champaign Alternates

https://archive.org/details/southafricanjour1319sout

Although the farmers on the Springbok Flats lost half their cotton crop last year owing to frost and the ravages of the boll worm, they are planting double the acreage this year.

The United States production of spelter in the first six months of 1917 is estimated to have been 364,000 short tons, as compared with 351,000 short tons during the last half of 1916.

The new wattle extract factory at Merebank, near Durban, is nearing completion. Equipment is almost complete, and production of extract may be looked forward to in the near future.

The recent floods on the coast of Natal have seriously retarded sugar-crushing operations. The turbine in the River Umhloti, supplying power to the Kearsney tea factory, has been entirely washed away to sea.

With reference to the paragraph appearing in the last issue of the *Journal* respecting the quantity of South-West diamonds available for local cutting, the production was stated to be 30,000 carats *per annum*. This, of course, should have read *per mensem*.

Mr. Zoutendyk, of the Capetown Customs Department, has submitted to the Government an interesting report on his recent visit to the Argentine, especially as regards the possibilities of trade relations between South Africa and that country.

Wood-pulp or wood-meal, which is used in the manufacture of explosives, has for years past been imported into South Africa packed in jute bags. A consignment of 30 tons, however, has lately been received packed in paper coverings. The results are stated to be quite satisfactory.

One of the principal private losses caused by the Natal floods has been the destruction of the bridge over the Umgeni attached to the quarry of Mr. Clarkson on the northern side of the river. This is an old established business, and much sympathy has been expressed with the owner.

Among the many forms of economy and substitution practised in Germany, one of the most widely advertised has been the collection of fruit kernels for the extraction of oil. *The Economist* states that it is reckoned that in 1916 approximately 3000 tons of kernels were collected, yielding about 126,000 kilos of oil.

Reporting on the 21st September on the price of corundum, the Trades Commissioner for the Union in London states that, for good material, the price delivered in the United Kingdom ranges from £17 to £20 per ton according to quality. The Trades Commissioner adds that nearly all minerals are now under the control of the Minister of Munitions.

The Industries Advisory Board is inquiring into the possibilities of encouraging cotton cultivation in the Union. The area expected to be placed under cotton during the ensuing season is estimated at from 7000 to 10,000 acres. Quite a number of farmers are planting cotton in Zululand. Upwards of 2000 acres have been planted in one district there.

Natal industrialists are seriously considering the further exploitation of the iron ore occurrences in the vicinity of Pietermaritzburg. A small blast furnace has been in existence for some years past at Sweetwaters, and the experience gained in the treatment of these ores should serve a useful purpose now that a revival of interest in the iron industry has taken place.

With reference to the possibility of the local extraction of oil from cloves from Zanzibar it is stated by the British Resident in his report for 1916 that the area under clove cultivation in the Zanzibar Protectorate is estimated at 60,000 acres. The output varies considerably, the trees bearing heavy crops every three to five years. The average output of recent years has been about 14,000,000 lb.

The manufacture of glycerine in Japan was commenced in 1916, and although the output is increasing it is not yet sufficient to supply the entire home demand. Until recently, Japanese fish oil was used as a basis for the manufacture of glycerine, but, with the expansion of the industry, animal fat from Australia and cocoanut oil from the South Seas are being used. The possibility of using bean oil is also under investigation.

In view of the likelihood that, after the war, the demand for commercial intelligence for the benefit of the trade of the United Kingdom is likely to be very much greater than it has been in the past, arrangements are being made by the Imperial Government for the establishment of an enlarged Commercial Intelligence Department and the development of the system of Trade Commissioners and Commercial Attachés.

Export of Dried Fruit.

The Farmers' Co-operative Dried Fruit Company (Wellington) recently forwarded to London a trial consignment of 5 tons of prunes. This resulted in an order for 50 tons (4000 boxes), in respect of which the company has received a most satisfactory report. Since then three other shipments of dried fruit have been made by the same company—in all about 6000 boxes, and cable advice has been received that two at least of these shipments have been sold with highly satisfactory results. Apricots realized 170s. per cwt. and pears 145s. at a time when Californian pears were selling at 105s.

Dealings in Chrome Ore.

Under an order dated 31st August by the British Minister of Munitions no person may purchase or take delivery of chrome ore of any grade, except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions; and, further, no person may sell, supply, or deliver chrome ore of any grade except to the holder and in accordance with the terms of such a permit. Permits in connection with this order are issued by the Director of Materials, Ref. A.M. 2/F.W.H., Ministry of Munitions, Hotel Victoria, Northumberland Avenue, London, W.C. 2.

Industrial Research in Japan.

The Parliament of Japan has authorized a grant of £200,000 towards the establishment and maintenance of a scientific and industrial research laboratory. In addition, the Imperial Household has made a grant of £100,000, whilst donations totalling £290,000 have also been received from other quarters. The principal object of the institution, which will be situated at Tokyo, is to assist in the application of modern methods to the development of Japanese industries, and the chief sections of the laboratory will be those devoted to researches in electricity, chemistry, electro-chemistry, textiles, and metallurgy.

Imperial Mineral Resources Bureau.

A Committee has been appointed by the Minister of Munitions to prepare a scheme for the establishment of an Imperial Mineral Resources Bureau to be located in London. This constitutes a step towards carrying out the recommendation of the Imperial War Conference, viz., "That it is desirable to establish in London an Imperial Mineral Resources Bureau, upon which should be represented Great Britain, the Dominions, India, and other parts of the Empire." Some

idea of the importance of the subject is afforded by the fact that the number of workers employed in the mines and quarries of the British Empire was at least 2½ millions in 1913, and that the value of the mineral products at the point of their production was about £150,000,000 in the same year.

Industrial Alcohol.

The factory which has been erected at Merebank, near Durban, for the manufacture of motor fuel is now complete and operations will be commenced on the arrival of two French experts, who are daily expected. The plant has been supplied by Messrs. Egrot, of Paris, under special permission of the French Government, and is of the most modern type. Special interest naturally attaches to the production of alcohol motor fuel at the present time, and to the price at which it will be available to the public. Nothing definite has yet been arranged in regard to price, but it is thought that this will be in the neighbourhood of 2s. 9d. per gallon. But for the high cost of the particular denaturants insisted upon by the Government for rendering the fuel unpotable, a lower price might have been possible.

Natal Creamery, Limited.

The Natal Creamery, Limited, has declared the full dividend of 10 per cent. on the last year's working, and has divided the surplus profits, approximately £2,500, amongst suppliers to the company pro rata to the value of their supplies.

The balance-sheet of the company states *inter alia* as follows:—"Various developments which your company have in view have been considerably hampered, but your directors are determined to do everything possible to secure new and retain the old business connections, and desire to specially emphasize the value of the co-operative principles of limited profits as shown in this report, which principle has resulted not only in your company reaching the position of the premier creamery company in the Union, but is being confirmed and adopted by farmers' co-operative meat, bacon, and creamery companies in this and the other Provinces."

Electric Steel Furnaces.

The use of the electric iron and steel furnace, both in the United States and in Canada, has made exceptional progress under war conditions. An American journal remarks that when the demand for steel exceeds the supply the scrap piles are searched and the electric furnace "experiences a boom because it is capable of making an excellent quality of steel from a comparatively poor quality of iron and steel scrap."

At the beginning of 1916 there were 73 electric steel furnaces in the United States producing 100,000 tons per annum; to-day, it is stated, there are over double this number with a yearly production exceeding 1,000,000 tons. In Canada the relative growth has been

even greater, the electric furnace steel production having increased from 61 tons in 1915 to 43,790 tons in 1916.

Potash Salts.

It has been known for several years past that an extensive deposit of potash salts exists in Abyssinia, and the United States Consul at Aden now reports that the rights (including a 35-years' concession from the Abyssinian Government) have been acquired by an Italian company which is actively engaged in opening up the deposit. It has been estimated that there are available at least 850,000 tons of the salt, averaging not less than 55 per cent. potash, and the deposit is being added to steadily by hot springs. The deposit is said to resemble those at Stassfurt, Germany, and the new discovery, from its nature and extent, promises to threaten the monopoly hitherto held by that country. A railway is being constructed from the mine to Fatimari, a small settlement 46 miles distant on the Red Sea, where a port will be established. A direct steamer service to America is also foreshadowed.

Economy in Milling.

The Industries Advisory Board has adopted the following resolution:—

> That in view of the anticipated shortage of food products and the increasing lack of shipping facilities, it is essential that the fullest use be made of the food supplies of the Union, thus reducing the necessity for importation of wheat and flour as far as possible; to accomplish this the Board recommends that the Government take into consideration the desirability of promulgating regulations for the purpose of providing that in the milling of wheat a larger proportion of flour and meal should be obtained than at present, and suggests that a percentage of approximately 80 per cent. be laid down as a standard amount of flour and meal to be obtained from wheat, and, further, that the Government recommends that the consumer can advantageously add from 15 per cent. to 20 per cent. of mealie meal to the flour or meal for the purpose of bread-making.

Glass Factory at Durban.

A small glass bottle factory has been established in Durban. Two or three different kinds of bottles have been manufactured, but at the moment the factory is making mostly six-ounce medicine bottles and small ink-bottles; "nip" bottles are also made. The old-fashioned method of "blowing" is adopted, three special workmen—two Hollanders and a Russian—having been engaged for the purpose. Sand is obtained near Durban, but a large quantity of broken glass is being worked up at present. The company is quite unable to cope with the orders which are being received, but the production, small as it is, is affording very welcome relief locally. Greater variety of manufacture would be undertaken but for the difficulty in obtaining satisfactory moulds, these as well as machinery being at the present time almost impossible to obtain.

During 1915 the Acting Trades Commissioner in London received an offer from a firm of engineers near Leeds for the supply to the

Union of a limited number of semi-automatic glass-making machines, the possession of which at the present time would be of enormous help to many industries requiring containers for their products. Unfortunately the enterprise failed at the last moment, and the offer had to be refused. There is little doubt that in the future glass bottle manufacture will become an important local industry, and those at present engaged in the modest attempt described above deserve every encouragement.

Sugar Refining in Canada.

The dimensions and prospects of the refinery (sugar) industry in Canada are indicated in a report (referred to in the *Board of Trade Journal* of 13th September) which has been prepared by the Commission appointed by the Dominion Government to inquire into questions affecting the cost of living.

The report states that the quantity of sugar refined in Canada during 1916 aggregated 345,089 short tons, valued at £9,494,623. The output in each of the three preceding years was 303,233 tons, 332,512 tons, and 319,752 tons respectively.

There are six refining companies in the Dominion controlling eight refineries. Five of the companies refine imported raw cane sugar exclusively; the sixth company refines both cane and beet sugar. The last-mentioned concern was established mainly for the manufacturing of beet sugar, but during 1916, out of a total production of 101,000,000 lb., only 19,000,000 lb. were from beet sugar, although it is stated that in Canada beet sugar can be produced ordinarily at a cheaper rate than cane sugar.

Until 1916 the production of Canadian refineries was absorbed by home consumption. Favourable conditions prevailing during that year, however, enabled the refiners to export 26,000 long tons overseas, and up to May, 1917, arrangements had been made for further exports of 35,000 tons of sugar. The capacity of the Canadian refineries is very much in excess of the demand for sugar for home consumption. Their output represents only about 60 per cent. of their capacity during any one year. It is stated that the refineries could certainly produce annually some 400,000,000 lb. of sugar in excess of their present output. The advantage to them of an export trade at satisfactory prices is thus apparent, but, the report states, it is impossible for Canadian refiners to compete for the United Kingdom market except when extraordinary conditions prevail.

Industries Advisory Board.

The Industries Advisory Board held a three-days session at the Town Hall, Durban, commencing on the 5th instant. Mr. C. G. Smith presided, and the members present were Sir Thomas Cullinan, Professor Stanley, Mr. E. Chappell, Mr. J. Pyott, Mr. W. R. Jackson, Mr. F. T. Nicholson, Mr. W. J. Laite, Mr. A. J. Chiappini, and Mr. A. Canham (Secretary). The Secretary for Mines and Industries (Mr. H. Warington Smyth) was also present. Mr. Kolbe (the representative of the Orange Free State) was unavoidably absent.

The Board had a very full agenda, including among other items:—

(1) Anomalies in Customs Tariff.
(2) Draft Bill for establishing minimum wages in certain occupations for women and young persons.
(3) Draft Factory Bill.
(4) Afforestation.
(5) Stimulation of cotton production in the Union.
(6) Industrial alcohol for use in manufactures.
(7) Conservation of food supplies.
(8) Branding of cattle in relation to the tanning industry.

The Board also dealt with a number of tariff matters which had been addressed to them by various interests in the Union. In most of these cases the Board decided to investigate the conditions obtaining in the various industries affected.

During the Board's visit, members had an opportunity of visiting a number of the more interesting industries in Durban.

The increase in the work of the Board has necessitated the appointment of a General Purpose Committee, with headquarters in Johannesburg, to deal with the heavy detailed work involved in most of the questions submitted for consideration.

During the session gratification was expressed that the results of the recent Census of Industries, which the Board was chiefly instrumental in securing, had indicated such satisfactory progress in industrial development. The opinion was expressed that the forthcoming Census would show a very considerable advance on the figures recently published.

The Silk Industry.

The following note on the silkworm industry, written by Mr. D. Gunn, of the Division of Entomology, has been submitted to the Scientific and Technical Committee by the Secretary for Agriculture:—

"Silkworm culture was begun in the Transvaal by the late Mr. C. B. Simpson, and this work was continued by Mr. C. W. Howard. After he left the Department I had charge of the work during part of 1908 and up till March, 1910. Numerous exhibitions and practical demonstrations were given at several agricultural shows in the Transvaal, and also in Zoutpansberg, the White River Settlement, and other places. Every possible opportunity was taken to foster the industry by cuttings, but I am sorry to state that no practical interest was taken in it by the people whom we were anxious to assist. No public interest was aroused and no protests were made when the work was discontinued in 1910.

"I may state that the United States Department of Agriculture, in an endeavour to assist the poor people of that country, did everything possible to place the silkworm industry upon a commercial basis, but the work ultimately had to be abandoned as the cost of labour and production was too high to ensure its success. The only countries in the world where this industry is conducted with success are Japan, China, India, parts of Italy and France, where there is an abundance of cheap labour. The wages paid to the workers in these countries

vary from 6d. to 1s. 3d. per day. In South Africa, where wages are high, the success of the industry would be an impossibility."

In connection with the foregoing report it may be noted that a fresh attempt to introduce silk-raising in the United States is being made by Dr. Osigian, an Armenian expert, who considers that the labour difficulty can be overcome by the adoption to a great extent of mechanical methods as well as by using cheap Mexican labour.

Some 10,000 mulberry trees were planted eighteen months ago on a 40-acre farm in Texas. It is expected that over 2000 lb. of cocoons will have been obtained by the end of the current year, and that within five years the growth of the trees will be sufficient to provide for twenty times this year's output of silk. In addition, it is stated that the industry has proved so successful during the short time it has been established that it is intended to plant 12,000 additional mulberry trees next year, and the plantation will be gradually increased until it covers more than 1000 acres.

Canada's Export Trade.

The Canadian Government Trade Commissioner (Mr. W. J. Egan) has circulated the following interesting data in reference to the export trade of Canada:—

"Canada as a source of supply to South African importers is appreciated more and more each year. The value of total exports for the past five years to South Africa are:—

1912.	1913.	1914.	1915.	1916.
£498,100	£685,000	£785,000	£952,335	£1,130,000

"In the year 1915, when many of your regular channels of trade were closed to you, Canada exported under 210 headings to South Africa, and, of these, increased exports or goods shipped for the first time, totalled 129 articles. In the year 1916 we shipped to you under 261 headings, and the new lines or increased exports numbered 159 articles.

"Canada's remarkable expansion in the exports of all kinds of domestic produce, in spite of the fact that so many of the able-bodied men of the country are at the battle-front, is shown in the following table, which is compiled for the twelve months ending February in each year:—

	1914.	1915.	1916.	1917.	Increase 1917 over 1914.
The Mine ...	£12,000,000	£10,720,000	£13,240,000	£17,146,000	42 %
The Fisheries ...	4,232,000	3,914,000	4,589,000	5,037,000	19 %
The Forest ...	8,704,000	8,609,000	10,550,000	11,385,000	30 %
Animal Produce	10,850,000	14,887,000	20,445,000	25,031,000	129 %
Agric. Products...	42,811,000	26,408,000	50,072,000	75,701,000	76 %
Manufactures ...	11,521,000	15,666,000	43,155,000	93,311,000	710 %
Miscellaneous ...	24,000	118,000	1,080,000	1,544,000	—
Total ...	£90,142,000	£80,322,000	£143,131,000	£229,155,000	154 %

"The striking increase of 710 per cent. in the output of manufactures is due to the efforts made to furnish the Allies with an abundance of munitions and other war supplies. By this effort Canada has disclosed unexpected industrial resources and capacity. It means also a process of refinement in all industries, which lifts Canadian plants to a high standardization of skill."

Hop Growing in South Africa.

The following statement, prepared by Mr. G. Shaw Scott, of the School of Agriculture, Glen (Orange Free State), has been submitted to the Scientific and Technical Committee by the Secretary for Agriculture:—

"Hop growing has been taken up several times in the Cape Province with considerable success. Some forty years back hops were cultivated at Newlands. About the same time a Mr. Robertson, of George, Cape Province, had a large patch. At an agricultural show during his time he took a silver cup offered for the best sample of hops grown in the Cape Colony. It is impossible to ascertain why in both cases these undertakings were given up.

"Coming to the present time, during the past few years a large number of hop sets and a quantity of seed were sent repeatedly from Europe by the Castle Brewery Company to this Department; these were distributed throughout South Africa. It was soon evident that hops apparently would not thrive at an altitude of more than about 1000 feet, consequently our attempt to establish the growth of them was futile. Since we have devoted our attention to the eastern and western portions of the Cape Province we have had really good results, more especially in the George District.

"With regard to the prospects of the industry I am certain suitable land will be found for the purpose at an early date. It is proposed by the Town Council of George to hand to this Department a plot of ground, about six acres in extent, for five years at a rental of £1 per annum for the purpose of making experiments. Tangible results can then be expected.

"The Southern Hemisphere hop belt lies between 30° and 46° latitude, i.e. from Durban in Africa to below Hobart in Tasmania; first rate grade hops are grown at the latter place. The hop is a plant of the central temperate zone and is cultivated in Europe, America, and Australia. Hops thrive best on the banks of streams and rivers. This indicates the greater suitability of alluvial land for their growth. In Tasmania, Oregon, and California irrigation is carried on to a great extent and has proved to be remunerative.

"Some of the samples of hops submitted to the head brewer, Castle Brewery, Bloemfontein, and to the writer, were found to be first-class, rich in lupulin, and the aroma was very good indeed. This latter is of great importance from a brewer's point of view. Prior to the war, hops were imported into South Africa for brewing purposes and bread-making to the value of from £40,000 to £50,000 per annum. These most certainly ought to be produced in South Africa. Locally grown hops moreover can be placed on the European market at a time when they would be appreciated by the brewers in consequence of stocks rapidly deteriorating towards the end of the season."

Meeting of Statistical Council.

The Statistical Council met in Pretoria on the 30th ultimo and completed the arrangements for the second Census of Manufactures, which is to be taken in January and February next. The census of June last—the results of which have already been published—was

necessarily and largely of an experimental character. It was the first real attempt on a scientific basis to ascertain the actual position of the manufacturing resources of the Union, and the experience gained by the Director and his staff will serve an extremely useful purpose in connection with forthcoming censuses of this nature.

The period to be covered by the next census will be the calendar year 1916, or the business year ending not earlier than the 1st July, 1916, and not later than the 30th June of the present year.

In the first census, factories employing fewer than four hands, including the proprietor, were not enumerated unless they used motive force. The Council has now decided to include every manufacturing or other establishment employing three or more persons, and to bring within the scope of the census businesses employing only one or two hands but using motive force or mechanical appliances such as boilers for steam-heating purposes, which hitherto have escaped enumeration. This alteration will chiefly affect the cheese industry, which during the last few years is known to have very largely increased both in volume and importance.

It has also been decided to include building, contracting, and allied industries, as has been done in the British Census of Industries, and also to secure returns as to the assembly in the Union and erection of articles imported in parts or sections.

The Council devoted considerable time to the consideration of the final draft of the form to be issued in connection with the Census of Agriculture which it has now been decided to take so as to cover the year ending 30th June, 1918. In the meantime arrangements will be made by the Director and his staff to explain to the supervisors, and through them to the farming community throughout the Union, the precise nature of the information required.

Other questions which were dealt with by the Council at its recent meeting were:—Migration returns, co-ordination of Provincial returns of education, and criminal and judicial statistics. During the course of its deliberations the Council had the assistance of the Secretary for Agriculture, the Secretary for Justice, the Assistant Secretary for Native Affairs, Colonel Muller (of the Transkeian Native Administration), and Mr. Ludorf, of the Office of the Superintendent of White Labour.

Chambers of Commerce.

TWENTIETH ANNUAL CONGRESS.

The annual Congress of South African Chambers of Commerce, which assembled in Johannesburg on the 22nd of last month, was attended by upwards of 70 delegates, amongst whom were many gentlemen who for a great number of years have figured prominently in the world of commerce. As is customary on these occasions, the past presidents of the congress occupy a place of honour immediately below the chairman, and it is worthy of note that amongst those present on this occasion were Mr. H. F. E. Pistorius, who filled the presidential chair as far back as 1892-3, Mr. J. W. Jagger, M.L.A. (1900-1904), Mr. William Hosken (1905-6), Mr. E. F. Bourke (1909), Mr. E. Chappell (1911), Mr. W. A. Martin (1912-15), and Mr. H. A. Oliver, C.M.G., M.L.A., (1916).

The president for the year was Mr. James McBride, of Durban, whose address at the opening of the congress covered a wide field of subjects, and served as an admirable lead to the discussions which followed during the remaining three days of the congress.

A feature of recent congresses has been the attendance, by invitation, of representatives of the various Government Departments more or less intimately concerned with commercial affairs. On this occasion there were present the Secretary for Finance (Mr. J. R. Leisk), the Secretary for Mines and Industries (Mr. H. Warington Smyth), the Commissioner of Inland Revenue (Mr. A. P. McLoughlin), the Commissioner of Customs and Excise (Mr. H. R. Eaton), the Under-Secretary for Agriculture (Mr. P. J. du Toit), the Secretary for Posts and Telegraphs (Mr. Twycross), and the Secretary, Industries Advisory Board (Mr. A. Canham).

Mr. Wickham, H.M. Trade Commissioner for South Africa, and Mr. Egan, representing the Canadian Government, were also present throughout the Congress.

The last day of the Congress has by custom become known amongst the delegates as "Railway day," and on this occasion the members had the advantage of the presence of Sir William Hoy, who dealt with a large variety of questions affecting his Administration.

During the congress no fewer than 116 general resolutions and 17 resolutions on railway matters were disposed of. Of these, quite a number had reference to industrial development. The President himself in his opening address spoke of the great industrial and agricultural changes which had taken place in South Africa as a result of war conditions. He said:

> "Although prior to 1914 our industries were making steady progress, they were still in a comparatively backward condition, but with the outbreak of war the position changed entirely, and while it is not easy to quote many specific instances of the advance

that has been made it may be said broadly that practically every industry has expanded to a considerable extent, and the more closely we study the question the more apparent this is. This rapid expansion has been brought about principally by the high freights and shortage of tonnage, and to the much higher laid down costs of all commodities imported from overseas. This naturally made it much easier for the local manufacturer to more than hold his own against outside competition, with the result that most of our manufacturers are now doing exceedingly well. The present prosperity, due practically to there being no serious competition from overseas, is not likely to continue after the war. Our manufacturers would, therefore, do well to keep this aspect of the of the position carefully before them, otherwise they will have a decided set-back when conditions as regards prices and competition are again normal. The Government is to be congratulated on the vigour with which it is now assisting the development of our industries through the Department of Industries.

"As regards agricultural development the present outlook is, in my opinion, brighter than ever it has been in the history of South Africa. The splendid rains we have had this season practically assures a bumper harvest next year, if nothing unforeseen happens, and, given a few more such seasons, we should not only be able to produce all our own requirements in foodstuffs and other necessaries, but still have a fair surplus for export. Farmers throughout the country, owing to the war, have never been as prosperous as they are now, and while present abnormal prices for all products cannot continue when things are normal again, they are going to remain on a comparatively high basis for some time to come, and it is questionable if they will ever be as low as they were in pre-war days. There is, therefore, every encouragement to farmers to go on increasing the production of all agricultural products, as they are practically assured of remunerative prices for many years ahead. The agricultural industry has undoubtedly made rapid strides during the last few years, but with our limited European population we can never become producers on a large scale, or hope to hold our own against the other dominions until we adopt, like them, a comprehensive scheme of land settlement and immigration. While the war is raging throughout the world the right class of settler cannot, of course, be obtained, but a great deal of preparation can be done in the meantime, as when the war is over there will be thousands of ex-soldiers anxious to settle on the land, and they will naturally select the Dominions offering the most attractive terms and conditions. Is our Government going to take advantage of this unique opportunity of securing large numbers of these brave men who have been fighting our battles, and who will make, I am sure, ideal settlers? Preference will naturally have to be given to our own men, but if the problem of land settlement and immigration is properly tackled, there should be plenty of suitable land available for many other ex-British soldiers in addition to our own."

One of the most interesting discussions of the congress arose on a motion of the Pretoria Chamber, as follows:—

This congress recommends that a definite policy should be laid

down by the Government for the post-war development of South Africa, embracing—

(*a*) a settled fiscal policy, protecting industries by means of Customs tariffs or bounties where it is considered that this means of protection is better suited to the nature of the industry;

(*b*) a permanent advisory board to make recommendations to Parliament regarding any adjustments considered necessary in the Customs Tariff, and the payment of bounties;

(*c*) a complete survey of the natural resources of South Africa, with a view to encouraging their exploitation, particularly the iron ore resources of the Union;

(*d*) land settlement and irrigation schemes;

(*e*) a publicity campaign to start immediately peace is concluded, advertising the resources of the country, with a special view to increasing and strengthening the white population.

At an early stage of the discussion the president invited the Secretary for Mines and Industries to address the congress as regards the organization recently brought into existence by the Government for handling purely industrial matters and the progress being made.

In the course of his address the Secretary for Mines and Industries first of all thanked the Chambers of Commerce on behalf of the Department for the assistance they had given in regard to the work of the Priority Committees, and referred to existing shipping difficulties with regard to imports.

After referring to the establishment by the Government of the Industries Advisory Board and of the Scientific and Technical Committee, under the chairmanship of Mr. Bernard Price, he explained the investigations of these two bodies under several headings.

He explained what had been done with regard to the manufacture of industrial alcohol, and stated that before the end of the year it was hoped it would be produced in commercial quantities.

The following matters were also referred to at some length:—

The prohibition of adulteration of leather; the investigation by the Board of Tariff Anomalies; timber and forestry questions; the prohibition of the export of scrap iron, and the probability of the erection of a blast furnace for the production of pig iron at an early date.

Reference was also made to the Factories Bill, which is being considered by the Advisory Board, and the Wages Board Bill, dealing with employment of women and young children.

In connection with the general survey of the resources of the Union, which is being instituted by the Scientific Committee, mention was made of the importance of a preliminary survey of and publication of facts regarding the known resources of South Africa, and the co-ordination of existing information relating thereto. Attention was drawn to the great importance of scientific investigation and scientific methods of management in regard to industrial matter, which had been perfected by Germany during the last decade.

The speaker laid stress on the importance of maintaining the quality of the output of the manufactures of the Union, and of producing at reasonable prices.

Reference was made to the beginning of an industry for treating the by-products of maize; to the copper industry of the country, and the remarkable growth in the output and quality of asbestos in the Prieska and Lydenburg Districts since the commencement of the war, and the discovery and production of corundum. The refining of tin, which has been attempted for the first time within the Union by the Zaaiplaats Company, was mentioned as an indication of the advance being made in developing and establishing industrial operations within the Union.

Further reference was made to the antimony production, to the steps being taken to recover arsenic from certain mines in the Union, and the search being made, with some prospect of success, for sulphur.

The Scientific Committee has been especially busy in the search for fertilizers, and details were given of the investigations being made by Dr. Marloth, Professor van der Riet, and Dr. Juritz.

Reference was then made to the detailed surveys, which are being instituted or recommended by the Scientific Committee in regard to certain classes of minerals, limestones, on which Mr. Wybergh is at present at work, botany, paper-making fibres by Dr. Juritz, water-power, and the national and educational resources available for scientific research.

In conclusion, the speaker laid special stress on the necessity for the building up of the scientific research spirit in the Universities, and the proper education by means of technical and vocational training of those who would be employed in the industries of the country.

In this connection reference was made to the Juvenile Advisory Boards which have been established by the Labour Department at certain centres, and to the useful and necessary work which is being commenced by these bodies, and for which a very useful future may be expected.

Reference was made during the course of the discussion to the census of industries which had just been taken by the Government, and to the proposed departmental census of unemployed being undertaken by the Labour Department, and attention was drawn to the necessity for greater organization in the matter of employment of labour in our various industries.

At a subsequent stage in the discussion the Secretary for Industries also drew attention to the large amount of work being done by the engineering shops of a character which, prior to the war, had never been attempted in the country. He referred to the casting of shoes and dies, hoes, shares, rails being manufactured at Vereeniging, sugar rollers being now produced in Natal and spare parts for agricultural and other machinery of all kinds being now manufactured in the Union and a statement was made that the figures of total production of industrial concerns, as notified by the Director of Census, were found to amount to a value of over thirty-six (36) millions sterling, a statement which was received with considerable interest.

In the course of subsequent discussion, both Mr. Jagger and Mr. Hosken remarked on the futility of suggesting a settled fiscal policy, the last-named remarking that some day they were going to have commonsense in South Africa and end the protection policy and have free trade.

The following morning the Pretoria representatives asked to be allowed to amend the preamble to the motion so as to make it read:

> "This congress recommends that the post-war policy of the Government should include (*a*) a policy of encouraging industries by means of tariffs or bounties, whichever is better suited to the nature of the industry."

In supporting the motion, although not entirely agreeing with every part of it, Mr. E. Chappell said that while free trade might be an ideal state of affairs it was one which he feared was wholly impracticable. If a number of countries had free trade and one other country set up a protective tariff that one country must flourish over the others. He was satisfied that every young country must adopt a measure of protection to enable its industries to take root, and South Africa had as good a chance in this respect as any other country.

Mr. Martin commented on the fact that protectionists were never satisfied with their protective tariffs. They always wanted more. Protection had to be paid for out of the primary industries, which in this country were mining and agriculture. It was not so much protection they needed in South Africa as good technical education and commercial training.

The discussion disclosed an overwhelming tendency in favour of the Pretoria motion, as amended, which was eventually adopted by 50 votes to 5.

The above result was referred to at the congress banquet by the Hon. H. Burton, K.C., Minister of Railways and Harbours. Dealing with the resolution passed he expressed the view that it had been characterized by the greatest moderation. There was only one thing—and he did not know that he actually regretted it—and that was the cavalier manner in which his two good old friends Mr. Jagger and Mr. Hosken had been routed with great slaughter. (Laughter.) Apparently with all the influence and eloquence at their command they could not muster more than five votes. (Laughter.) They were in this country the "Heavenly Twins" of free trade. (Laughter.) He had read the report of the discussion with great interest, and the adverse vote had given him much food for thought. The lessons of the war had brought home to most of them the feeling that there was no inherent salvation or sacrosanctity in either the doctrine of free trade or protection. (Hear, hear.) Each country must decide for itself, and in a young country like South Africa it seemed to be impossible to avoid the conclusion that the industries growing up and struggling for existence should have some protection. But the point to bear in mind was that they must not have too much of either. (Hear, hear.)

FACTORY ACT.

The congress endorsed the principle of factory legislation, and urged the Government to introduce a Bill, embracing all sections of industrial and commercial enterprise.

REGULATION OF WAGES.

The Durban Chamber submitted the following motion:—

That this congress generally approves the purposes of the Select Committee on the subject matter of the Regulations of Wages

(Specified Trades) Bill, as indicated in paragraph 14 of their report of 24th May, 1917, as follows:—

Your committee therefore recommends that legislation should be introduced as soon as possible on the following lines:

(1) That the Government should be empowered to establish Trade Boards for specified trades and industries in particular districts, with due representation of employers and employees.

(2) That these boards should have power to fix a minimum rate of wages for women and young persons employed in these trades and industries, with due provision for workers paid by time, for those working on other forms of contract.

(3) That the boards should have power also to lay down conditions on which learners and apprentices should be employed, and to fix, if necessary, the number of such in proportion to the number of fully qualified workers.

(4) That the legislation should follow, with due regard to South African conditions, the lines of the British Act of 1909.

The congress whilst approving in principle of the adoption of a measure of the character indicated in the Durban resolution, was of opinion that the details of the proposed legislation required very careful consideration. The resolution was accordingly amended to read:—

That this congress generally approves of the provisions of the Select Committee in respect of the subject matter of the "Regulation of Wages in certain Specified Trades Bill," and requests ample opportunity for the consideration of its terms by commercial and industrial bodies;

and in this form it was agreed to.

Weights and Measures.

On the motion of the Johannesburg Chamber, the following resolution was agreed to without discussion:—

That the Government be urged to introduce immediately a Bill to consolidate the laws of the four Provinces of the Union relating to weights and measures, providing, *inter alia*,

(*a*) that all goods sold by weight or measure shall be sold by net weight or imperial measure;

(*b*) that all South African produce shall be sold at per 100 lb. net weight, with the exception of articles of pastoral produce (such as wool, mohair, hides, horns, skins, and feathers).

Customs Tariff Revision on Necessaries of Life.

The following motion by the Kimberley Chamber received general approval and was agreed to with two dissentients:—

That this congress strongly urges upon the Government a revision at an early date of the present Customs Tariff with a view to lessening the duties upon the necessaries of life.

Mr. Jagger explained that he disapproved of this resolution, not because he was opposed to the reduction of duties on the necessaries

of life, but because he condemned the policy of the Government in getting all money for war purposes out of Loan Account. He held that the Government should lay on taxation, but that the proceeds should be used for war expenses and not for ordinary expenditure, as was now being done.

SUGGESTED EXCISE ON TOBACCO.

The congress agreed to a resolution favouring the imposition of an excise duty on South African grown tobacco.

PREFERENTIAL RAILWAY RATES.

The following resolution, moved by the Johannesburg Chamber, was carried after a brief discussion:—

> That in view of the serious increase in the cost of living throughout South Africa, this congress urges that preferential railway rates, except for export, should be abolished by the rate for the local article being applied to the imported, and that if any protection be necessary it should be provided through the Customs or by other means.

RETURNED SOLDIERS.

The Johannesburg Chamber submitted the following resolution, which was carried:—

> (1) That the Government should consider the necessity of providing suitable employment for returned soldiers, and especially those partially disabled. (2) This congress confirms the decisions of the Chambers of Commerce throughout South Africa in regard to the policy they have adopted of reinstating all returned soldiers who were previously in their employ, and recommends to members that preference should be given in all cases to returned soldiers in any vacancies which may occur in their establishments.

ELECTION OF OFFICERS.

The election of officers, which took place at the close of the session, resulted in the following appointments:—

President: Mr. W. Duncan Baxter, M.L.A., Capetown.
Chairman, General Committee: Mr. J. W. Jagger, M.L.A., Capetown.
Vice-Chairman, General Committee: Mr. E. Chappell, Johannesburg.
Hon. Treasurer: Mr. H. R. Beard, Capetown.

Durban has been selected as the venue for the next meeting of the congress.

The secretarial duties of the recent congress, it should be stated, were in the hands of Mr. Ernest Gauntlett, the Secretary of the Capetown Chamber of Commerce.

The Census of Industries.

ABSTRACT OF RESULTS.

The following statement regarding the results of the recent Census of Industries has been furnished by the Acting Director of Census:—

The subjoined preliminary tables furnish in summarized form the principal results of the Census of Factories and Productive Industries in the Union for the business year 1915-1916, taken in terms of Regulations framed under the Statistics Act, 1914 (Government Notice No. 629 of the 10th May, 1917). These figures, which are subject to final audit, are published in advance of the report which will shortly be issued and will contain tables giving detailed information in respect of the various classes of productive industries covered by the Census, and also particulars of certain further returns not yet finally audited. The final results will show approximately a gross production as follows for the Union:—

All establishments, exclusive of the Railway Workshops	£36,000,000
Railway Workshops	4,300,000
Total Gross Production	£40,300,000

1. *Period Covered.*—The returns have been rendered for the calendar year 1915, or the business year ending not earlier than 1st July, 1915, and not later than 30th June, 1916, i.e. substantially the Union business year 1915-1916.

2. *Definition of "Factory."*—The term "factory" was deemed to include every manufacturing or other establishment in the Union—

(1) (*a*) employing four or more hands, including the proprietor or manager or other person in charge thereof; or

(*b*) employing any form of motive power, excluding manual labour; and

(2) engaged upon any work of production or upon any other industrial process (excluding mining and quarrying), but including any industry relating to

(*a*) the treatment of raw material, the product of agricultural and pastoral pursuits;

(*b*) the extraction or treatment of oils and fat whether animal, vegetable, or mineral;

(*c*) processes in stone, clay, glass, or such-like material;

(*d*) working in wood;

(*e*) metal, engineering, machinery, and cutlery works;

(*f*) the preparation, treatment, or preserving of foods, drinks, and condiments;

(*g*) the production of clothing, textile fabrics, and similar articles;

(*h*) books, paper, printing, and engraving;
(*j*) arms and explosives;
(*k*) vehicles (mechanically propelled or otherwise), fittings for and parts of vehicles, saddlery, and harness;
(*l*) ship and boat building;
(*m*) furniture, bedding, and upholstery;
(*n*) drugs, chemicals (including fertilizers and by-products), paints, and varnishes;
(*p*) surgical, dental, and other scientific instruments;
(*q*) jewellery, timepieces, and plated ware;
(*r*) heat, light, and power;
(*s*) leatherware;
(*t*) housebuilding; and
(*u*) any other matter not enumerated.

3. *Scope of Returns.*—The returns from each factory covered the following matters:—

(1) Description of establishment.
(2) Year to which return refers.
(3) Capital.
(4) Average number of persons employed during year classified according to race, sex, and age.
(5) Amount of salaries and wages paid to the various classes of employees during year.
(6) Cost of fuel and light used during year.
(7) Motive power employed.
(8) Classification, quantity, and value of materials used and articles produced and value of repair and other work done during year.

4. *Number of Separate Factories.*—The total number of separate factories making returns in the Union and in each Province, and in each class of industry, was as follows:—

NUMBER OF FACTORIES.

Classification of Industries.	Cape.	Natal.	Transvaal.	O.F.S.	Union.
Treatment of raw materials, the product of agricultural and pastoral pursuits	65	11	7	1	84
Processes in stone, clay, earthenware, and glass	87	29	83	25	224
Working in wood	91	29	36	9	165
Metals, engineering, machinery, and cutlery	157	73	231	31	492
Preparation, treatment, and preserving of foods, drinks, and condiments	712	192	311	115	1330
Production of clothing, textile fabrics, and similar articles	281	53	124	21	479
Books, paper, printing, and engraving	120	44	65	12	241
Vehicles (mechanically propelled and otherwise) fittings for, and parts of vehicles, saddlery, and harness	194	58	88	26	366

Classification of Industries.	Cape.	Natal.	Trans-vaal.	O.F.S.	Union.
Ship and boat building and repairing	4	5	—	—	9
Furniture, bedding, and upholstery ...	60	19	38	—	117
Drugs, chemicals (including fertilizers and by-products), paints, varnishes, and allied products	31	19	25	—	75
Surgical, dental, and other scientific instruments and apparatus	5	4	5	—	14
Jewellery, timepieces, and plated ware	9	7	9	—	25
Heat, light, and power	42	22	49	14	127
Leatherware (excluding boots and shoes, harness and saddlery)	2	—	—	—	2
Building and contracting	140	35	80	30	285
Other industries	6	4	2	—	12
Total...	2006	604	1153	284	4047

5. *Capital.*—The amount of capital returned as invested in the various Provinces was as follows:—

CAPITAL INVESTED.

Province.	*Amount.*
Cape of Good Hope	£14,941,000
Natal	10,657,000
Transvaal	17,533,000
Orange Free State	2,334,000
Union	£45,465,000

6. *Average Number of Persons Employed and Wages.*—The returns show the following average numbers of persons classified according to race and sex employed during the year and the amounts of wages paid:—

(i) PERSONS EMPLOYED.

Province.	White Persons.		Coloured Persons.						Total.		Grand Total.
			Native.		Asiatic.		Other Coloured.				
	Male.	Female.	M.	F.	M.	F.	M.	F.	M.	F.	
Cape of Good Hope	14,554	2,292	5,918	278	233	4	10,656	3,238	31,361	5,812	37,173
Natal ...	6,058	626	7,299	65	9,733	1,095	821	73	23,911	1,859	25,770
Transvaal ...	12,085	1,124	18,550	29	114	7	306	12	31,055	1,172	32,227
Orange Free State	1,582	522	2,088	11	1	—	56	4	3,727	537	4,264
Union ...	34,279	4,564	33,855	383	10,081	1,106	11,839	3,327	90,054	9,380	99,434

(ii) WAGES PAID.

Province.	White Persons.	Coloured Persons.	Total.
	£	£	£
Cape of Good Hope	2,062,000	920,000	2,982,000
Natal	1,172,000	487,000	1,659,000
Transvaal	3,110,000	673,000	3,783,000
Orange Free State	289,000	68,000	357,000
Union	6,633,000	2,148,000	8,781,000

7. *Cost of Fuel and Light.*—The cost of fuel and light in each Province was returned as follows:—

COST OF FUEL AND LIGHT.

Province.	*Cost.*
Cape of Good Hope	£268,000
Natal	192,000
Transvaal	722,000
Orange Free State	45,000
Union	£1,227,000

8. *Motive Power.*—The nature of motive power employed and the horse-power of engines were returned as follows:—

MOTIVE POWER.

Province.	Establishments using									
	Electricity.		Steam.		Oil.		Gas.		Water.	
	Establishments.	H.P.	Establishments.	H.P.	Establishments.	H.P.	Establishments.	H.P.	Establishments.	H.P.
Cape of Good Hope	535	21,040	243	222,092	275	4,131	96	2,568	101	1,173
Natal ...	203	13,063	163	39,988	57	981	23	1,192	17	756
Transvaal ...	430	84,634	226	294,956	63	500	36	1,224	23	1,387
Orange Free State	46	2,492	66	7,628	45	373	26	1,282	11	443
Union...	1,214	121,229	698	564,664	440	5,985	181	6,266	152	3,759

9. *Value of Materials Used and Articles Produced.*—The value of materials used and articles produced and work done in each Province as shown in the returns is as follows:—

VALUE OF MATERIALS USED AND ARTICLES PRODUCED.

Province.	Materials used.	Articles produced and work done.	Value added in process of manufacture.
	£	£	£
Cape of Good Hope	9,273,000	14,761,000	5,488,000
Natal	5,362,000	9,314,000	3,952,000
Transvaal	6,141,000	13,731,000	7,590,000
Orange Free State	1,202,000	1,885,000	683,000
Union	21,978,000	39,691,000	17,713,000

[NOTE.—It will be observed that the value of manufactured articles, given in the October issue of the *Journal* as 36 million sterling, has been increased by over 3½ millions, the total now standing at approximately 40 millions. The more detailed statement and report by the Acting Director of Census is expected to appear in blue-book form in the course of the next three or four weeks.—ACTING EDITOR.]

REGULATIONS FOR NEXT CENSUS.

The following regulations have been promulgated, relating to the taking of the next Census of Industries in the Union in respect of the calendar year 1916, or the business year ending not earlier than the 1st July, 1916, and not later than the 30th June, 1917:—

1. For the purposes of these regulations a factory shall be deemed to be and include every manufacturing or other establishment in the Union

(1) (*a*) employing three or more hands, including the proprietor or manager or other person in charge thereof; or
(*b*) employing any form of motive power excluding manual labour; or
(*c*) employing any boiler for steam-heating purposes; and

(2) engaged upon any work of production or upon any other industrial process excluding mining and quarrying, but including any industry relating to
(*a*) the treatment of raw material, the product of agricultural and pastoral pursuits;
(*b*) the extraction or treatment of oils and fat, whether animal, vegetable, or mineral;
(*c*) processes in stone, clay, glass, or such like material;
(*d*) working in wood;
(*e*) metal, engineering, machinery, and cutlery works;
(*f*) the preparation, treatment, or preserving of foods, drinks, and condiments;
(*g*) the production of clothing, textile fabrics, and similar articles;

(*h*) books, paper, printing, and engraving;
(*j*) arms and explosives;
(*k*) vehicles (mechanically propelled or otherwise), fittings for, and parts of vehicles, saddlery, and harness;
(*l*) ship and boat building;
(*m*) furniture, bedding, and upholstery;
(*n*) drugs, chemicals (including fertilizers and by-products), paints, and varnishes;
(*p*) surgical, dental, and other scientific instruments;
(*q*) jewellery, timepieces, and plated ware;
(*r*) heat, light, and power;
(*s*) leatherware;
(*t*) any other matter not enumerated.

2. The person in charge of any factory shall on or before the 31st day of March, 1918, render on a form which he shall obtain from the Supervising Officer of the district in which such factory is situated, as specified in Regulation No. 5 hereof, or from the Director of Census and Statistics, Pretoria, a return furnishing all the particulars and information prescribed in Regulation No. 4 hereof in respect of such factory for the calendar year 1916 or the business year ending not earlier than 1st July, 1916, and not later than 30th June, 1917. Such return shall be delivered to the Supervising Officer, or, if desired, to the Director of Census and Statistics, Pretoria, on or before the said 31st day of March, 1918.

3. Any person in charge of any factory who, without reasonable cause, makes default in complying with these regulations shall be guilty of an offence and liable on conviction to a fine not exceeding twenty-five pounds, or, in the case of a continuing default, to a fine not exceeding one pound for every day during which the default continues.

4. The following shall be the matters prescribed in the return required under these regulations:—

(1) Description of establishment.
(2) Year to which return refers.
(3) Capital.
(4) Average number of persons employed during year classified according to race, sex, and age.
(5) Amount of salaries and wages paid to the various classes of employees during year.
(6) Cost of fuel and light used during year.
(7) Motive power employed.
(8) Classification, quantity, and value of materials used and articles produced, and value of repair and other work done during year.

5. The following persons shall be supervisors in the various magisterial districts of the Union:—

Capetown, Wynberg, and Simonstown—
The Supervisor of the Industrial Census, c/o the Labour Registration Officer, 59 Parliament Street, Capetown.

Johannesburg—
The Supervisor of the Industrial Census, c/o Inspector of White Labour, New Law Courts, Johannesburg.

Boksburg—
The Supervisor of the Industrial Census, c/o Mining Commissioner, Boksburg.
Pretoria—
The Supervisor of the Industrial Census, Census Office, Pretoria.
Durban—
The Supervisor of the Industrial Census, c/o Assistant Inspector of White Labour, Old Court-house, Durban.
In all other Districts—
The Supervisor of the Industrial Census, c/o the Resident Magistrate.

Chloride of Lime.

ONE of the many urgent problems which have arisen in South Africa since the outbreak of the war has been the discovery of a suitable disinfecting and oxidizing agent to take the place of permanganate of potash, which, owing to the cutting off of supplies of potash salts from Germany, is now only obtainable in very small quantities at prohibitive prices.

It is noted with satisfaction, therefore, that a well-known South African firm of chemical manufacturers recently erected a plant for the production of chloride of lime, the demand for which is proving so insistent that the firm in question, in order to meet the situation, has taken steps temporarily to utilize their gold chlorination plant for the purpose. By this means the company has succeeded in supplying the most pressing needs of clients, pending the erection of the special plant necessary for the production of the article on a larger scale.

The new plant has been designed to supply the whole of the estimated requirements of South Africa, and the successful production of this important commodity from materials obtained wholly within the Union, marks a further step in the industrial development of the country.

South African Fibre Plants.

I.—AMBARI OR DECCAN HEMP: *HIBISCUS CANNABINUS L.*

By I. B. Pole-Evans, M.A., B.Sc., F.L.S.,
Chief, Division of Botany and Plant Pathology.

(*With Plates I-VI.*)

Since the outbreak of war more than usual interest has been displayed by the public in the resources of South Africa as regards fibre plants, oil-producing plants, medicinal plants, tanning plants, and dye plants, with the result that numerous inquiries, often accompanied by specimens, have been submitted to the Division of Botany. Much valuable information relating to these economic plants and their distribution throughout the Union has thus been obtained.

In the present article one of these plants, which would seem to deserve some attention, not only from botanists, but also from the merchant and farmer, will be dealt with. The plant is known botanically as *Hibiscus cannabinus L.* It is also called Ambari Hemp, Deccan Hemp, Gambo Hemp, and Bimlipatam Jute. Locally it has been referred to as "The Wild Stock Rose." *Hibiscus cannabinus* produces a textile fibre which can be used for the manufacture of coarse woven articles, such as bags and sacks, hessians, and horse-cloths. It can also be employed for cheap cordage and yarns. The fibre is bright and glossy, but coarse and harsh.

The plant is a native of Africa, but now widely distributed throughout India, Asia, and Australia.

In India it is very largely cultivated for local use, but from investigations which have recently been given to it by the two Imperial economic botanists, resulting in the production of improved varieties from which the best specimens of fibre yet submitted to London merchants have been obtained, there is reason to believe that this plant will become more extensively grown for export trade.

In South Africa at the present time *Hibiscus cannabinus L.* as a fibre plant is practically unknown. It is certainly not cultivated, but in many places is looked upon as a most noxious weed.

In India, where its cultivation is firmly established, two spinning mills have been erected for some years for specially dealing with this fibre. From it practically all the agricultural cordage used in India is manufactured locally. It is also employed in making gunnies, coarse sack cloth, canvas, fishing nets, and paper.

Hibiscus cannabinus is an erect annual plant, attaining in South Africa an average height of 5-11 feet. In the veld it exhibits considerable variation as regards its habit of branching, time of maturity, and robustness—points which all need careful attention when seed

Plate I.] Fig. 1. Fig. 2.

is harvested. Some plants, when growing in the open, branch profusely (Plates I and IV), others frequently show no tendency to do so even under similar conditions.

The stem and leaf-stalks are prickly. The leaves are deeply divided and usually composed of 5-7 lobes (Plate II, Fig. 3).

The flowers are borne on the main stem and branches on a very short stalk in the axil of the leaf and open singly from below upwards, in the early hours of the morning. The flowers are creamy-white to yellow with a dark purple eye (Plate II, Fig. 2).

The seed capsule when ripe is globose, pointed, and bristly (Plate II, Fig. 1).

The plant has been observed by the writer as a common weed in all the warmer parts of the Transvaal, especially in the Barberton, Waterberg, and Zoutpansberg Districts. It also occurs fairly plentifully in Zululand.

Plate III illustrates a typical invasion of mealie lands by this plant in the Zoutpansberg District. At the time when the photograph was taken (10th September, 1917) practically all the seed capsules were ripe and had shed their seed.

Plate V depicts some plants taken from this heavily-infected tract of land and tied into bundles ready for fibre extraction. These plants were gathered, bundled, and forwarded to the Botanical Laboratories, Pretoria, by Mr. Closterschulte, of the Westfalia Estates, Duivels Kloof. In spite of their age an excellent sample of fibre has been obtained from them.

In some of the areas mentioned above the plant thrives to such an extraordinary extent that the writer has seen large patches, both of virgin veld and "lands" so completely covered that it was almost impossible to walk through it, so dense was the growth of these plants. The plants thrive best on dry, sandy, well-ventilated soils.

In India about 20 lb. of seed are sown to the acre and it is put in broadcast. The crop usually takes 5-6 months to mature. The plants are either reaped with a mower or pulled out by the roots as soon as the first seed-pods are ripe and while the upper portion of the plant is still in flower.

After reaping, the plants are tied into bundles and then retted in water for ten days or more. Running water, if obtainable, is preferable for this operation. The bundles are first placed in an upright position in water so that the thicker root ends may be thoroughly soaked. After a couple of days the bundles are laid horizontally and entirely immersed.

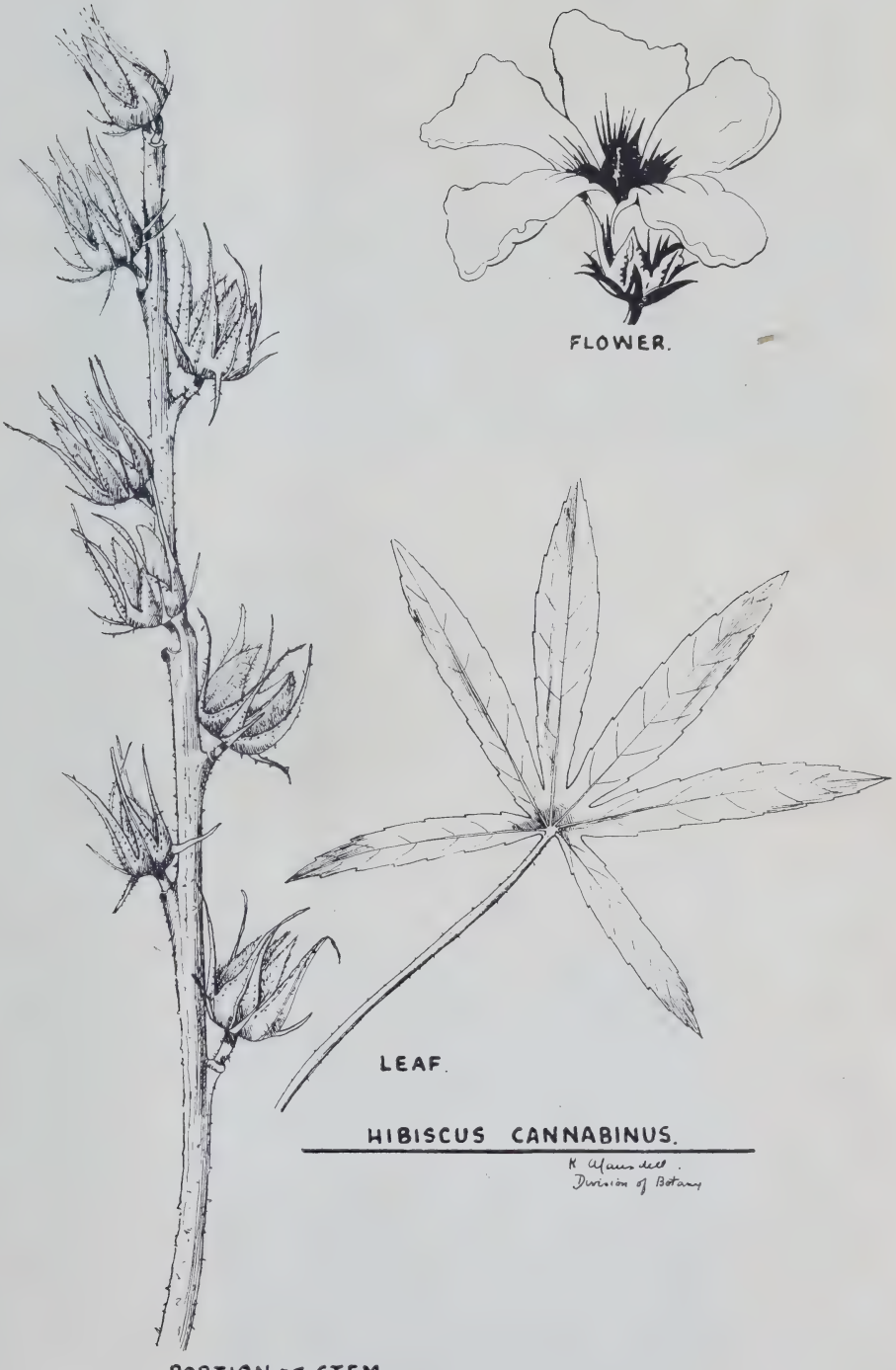
As soon as the retting has advanced sufficiently the fibre is stripped off by hand and cleaned by dashing it against the surface of the water or a board erected for the purpose. After washing, it is wrung out and hung up to dry for a day. It is then twisted into hanks and pressed into bales of some 400 lb. weight.

The yield of fibre per acre in India is said to be from 1-2 tons; no statistics regarding the yield per acre in South Africa are yet available.

Samples of fibre from this plant growing in the Transvaal have been submitted by the Department of Agriculture to the Imperial Institute in London, for analysis and report, on several occasions. As far back as June, 1910, a small sample of this fibre, weighing

Fig. 2.

FLOWER.



LEAF.

HIBISCUS CANNABINUS.

K. Ahmed del.
Division of Botany

PORTION OF STEM.

SHOWING CAPSULES.

Plate II.] Fig. 1. Fig. 3.

Photo. by I. B. Pole-Evans.]

Plate III.—Hibiscus cannabinus growing in old mealie lands on the farm Waterval, Duivels Kloof, Transvaal.

Photo. by I. B. Pole-Evans.]

Plate IV.—A much-branched plant of *Hibiscus cannabinus* growing on the farm Waterval, Duivels Kloof, and undesirable for seed purposes.

10¼ oz., and obtained from Duivels Kloof in the Transvaal, was reported upon by the Imperial Institute as follows:—

"The sample consisted of two bundles of nearly white, clean fibre, of fair lustre, with a slight greenish tint. One bundle consisted of much harsher and more strappy fibre than the other. In both cases the fibre was gummy and insufficiently retted. Strength, good; length of staple, 3 feet 6 inches. The fibre was unsuitable for chemical examination.

"*Commercial Value.*—If properly prepared these fibres would command a fair price, as they are of excellent colour and have good strength. But in their present insufficiently retted, strappy condition, they would be of little or no commercial value, since they could not be employed for spinning purposes.

"The well-prepared fibre of *Hibiscus cannabinus* is exported from India under the name of 'Bimlipatam jute,' and finds a market as a jute substitute at approximately the same price as the medium qualities of jute. A specimen of this Indian Hibiscus fibre is sent herewith, which is worth about £15 per ton at the present time (September, 1909)."

A further sample of this fibre, weighing 2 lb. 1½ oz., was obtained from Mr. M. Macpherson, of Barberton, Transvaal, and submitted to the Imperial Institute in July, 1909. The Institute reported as follows:—

"The fibre had a fair lustre and an irregular pale greyish-brown colour. It had not been well prepared, but the whole of the material was gummy and some parts were strappy and contained a good deal of adherent barky matter; these defects were probably due to insufficient retting. Strength, good. Length of staple about 6 feet. The fibre was not submitted to chemical examination.

"The tangled state of the sample would also depreciate its value, as it could not be used for spinning purposes without the expenditure of much labour. Well-prepared Hibiscus fibre could be used as a substitute for jute and would probably be worth about the same as 'medium jute,' which is now selling at £15 per ton in the London market."

Recently the fibre was brought more prominently to the Department's notice by Mr. W. R. Pedley, of Nylstroom, Transvaal.

Mr. Pedley, in a letter to the Government Botanist, dated the 19th June, 1916, in asking for advice on the subject, wrote as follows:—

"The plant from which this fibre is taken grows exceedingly well in the sandy soil of the Northern Districts, and, should it prove of commercial value, would make a very payable crop, as it can be grown in our poorest soil with a minimum rainfall.

"The chief difficulty I fear is the length of time it must remain in water to clear it of vegetable matter.

"The sample I am sending has been in water for over eight weeks and still has a certain amount of vegetable matter adhering.

"The vegetable matter can be got rid of by boiling, but that process discolours the fibre to some extent, in addition to which it would hardly be practicable to treat large quantities in that way.

Photo. by I. B. Pole-Evans.]

Plate V.—Bundles of *Hibiscus cannabinus* from Westfalia Estate, Duivels Kloof, Transvaal.

Photo. by I. B. Pole-Evans.]

Plate VI.—Bundle of *Hibiscus cannabinus* ready for retting and two lots of fibre extracted from similar sized bundles.

"I shall be glad of your opinion at an early date with a view to collecting and distributing seed, which must be sown early in the spring, as it takes some five or six months to mature."

The identity of the fibre was soon established and all the available information regarding the plant and preparation of the fibre placed at Mr. Pedley's disposal.

On the 26th of June, in a further letter on the subject, Mr. Pedley communicated the following interesting notes:—

"This plant, or rather weed, has been a curse to me since I have been farming here, and not alone to me but to every farmer around; in fact some have given up lands on account of it. It grows stoutly to the detriment of everything else. It has taken me three years to clear one of my lands of it sufficiently to raise a crop of mealies, and even now I anticipate a good germination with the first rains.

"To give you some idea of the durability of the fibre I enclose with other specimens a small sample taken from the upholstery of my cart, where it has been for the last six months, prior to which it was lying on a 'land' for about eighteen months, from whence I carted about two wagon loads to my cattle kraal, where the cattle trampled it to its present state.

"I am also forwarding you another sample of the fibre which was cut green, cured, and then placed in water. The other sample I sent you was from plants cut green (before seed-pods opened) and put straight into water.

"I should like to know which you consider the better sample and I will on receipt of your reply send you about 4 lb. I have a quantity of each in water, and will take the fibre from whichever you may think the best. Personally I see little or no difference.

"The plant grows to an average height of 5 or 6 feet, and, where allowed to grow unmolested, grows so densely that it is extremely difficult to get oxen to face it when ploughing.

"Also, owing to its spiny nature it is a difficult plant to handle, but that could be overcome by using a reaping and binding machine. After about two days in water the spines cease to be troublesome."

In August Mr. Pedley forwarded two bundles of fibre, each weighing about 4 lb. The fibre in one bundle was stated to have been taken from plants which were cut green and cured, and then immersed in water for about nine weeks. The fibre in the other bundle had been extracted from plants which had ripened their seeds and had dried out on the land. This had been immersed in water for some 27 days.

These two samples were forwarded through the Department of Industries to London for analysis and report, but were unfortunately lost in transit between the Trades Commissioner's Office and the Imperial Institute.

Fortunately Mr. Pedley was able to furnish a further supply of each sample and this in due course reached the Imperial Institute.

The reports on both samples are as follows:—

IMPERIAL INSTITUTE.

Report No. 1.—Results of the Examination of Hibiscus cannabinus *fibre from South Africa.*

Imperial Institute No. 1679/17/1; date 26th July, 1917.

Reference.—Letter No. T.C.85/16, dated 31st March, 1917, from the Trades Commissioner.

Number or Mark and Weight of Sample.—"Fibre of *Hibiscus cannabinus*, cut green and immersed in water for 9 weeks. No. 141." Weight 3½ lb.

Description.—This fibre was of very variable character and colour. It was rather harsh, and a considerable portion of the sample was stiff and gummy, and had bark adhering to it. The better cleaned portions were dull and weak and evidently over-retted. On the whole the material was not well prepared.

Strength.—Uneven, but fair on the whole.

Length of Staple.—From 2 feet 6 inches to 4 feet 6 inches, mostly about 3 feet.

Results of Examination:—

	Present sample.	"Bimlipatam Jute" (*H. cannabinus*).
Moisture, per cent.	8.9	12.5
Ash, per cent.	0.7	1.3
(*a*) Hydrolysis, loss, per cent. ...	13.1	11.8
(*b*) Hydrolysis, loss, per cent. ...	19.7	15.1
Acid purification, loss	3.0	—
Loss on washing in water	2.3	75.4
Cellulose	73.0	75.4

Commercial Valuation.—The fibre was submitted to a firm of fibre merchants who stated that it was of similar quality to Bimlipatam jute and suitable for use by jute spinners. Its value in the open market (i.e. if saleable without official control) would be about £45 to £50 per ton at the present time (July, 1917). The pre-war value would have been £15 to £18 per ton.

IMPERIAL INSTITUTE.

Report No. 2.—Results of the Examination of Hibiscus cannabinus *fibre from South Africa.*

Imperial Institute No. 1679/17/2; dated 26th July, 1917.

Reference.—Letter No. T.C.85/16, dated 31st March, 1917, from Trades Commissioner.

Number or Mark and Weight of Sample.—"Fibre of *H. cannabinus*, cut after the seeds have ripened, and immersed 27 days. No. 142." Weight, 3½ lb.

Description.—Harsh fibre, of dirty grey colour, but fairly lustrous. The material was gummy in parts and some adherent bark was present, but it had been more evenly and carefully retted than the preceding sample No. 141.

Strength.—The fibre was of fairly good strength, and stronger on the whole than sample No. 141.

Length of Staple.—From 3 feet to 5 feet; average, 4 feet.

Results of Examination:—

	Present sample.	"Bimlipatam Jute" (*H. cannabinus*).
Moisture, per cent.	10.4	12.5
Ash, per cent.	1.2	1.3
(*a*) Hydrolysis, loss, per cent. ...	13.5	11.8
(*b*) Hydrolysis, loss, per cent. ...	16.3	15.1
Acid purification, loss, per cent. ...	1.0	—
Cellulose, per cent.	72.0	75.4
Loss on washing in water	1.2	—

Commercial Valuation.—The fibre was submitted to a firm of fibre merchants, who stated that if properly prepared it would be quite suitable for spinning with jute. They stated that its present value in the open market would be about £45 per ton, and that its pre-war value would have been about £15 per ton.

Remarks.—This fibre is of better strength than sample No. 141, although inferior to it in colour. Both samples are short in staple and not of very good quality, but similar fibres would be readily saleable. The merchants who valued the samples desired to be informed when commercial supplies of the fibre become available.

While these samples were under investigation at the Imperial Institute, the extraction of the fibre has received some attention at the Botanical Laboratories, Pretoria, with such facilities as are at present available, and it has been proved conclusively that there is no difficulty in retting the fibre under South African conditions.

With the temperature of the water varying from 18° C.-26° C., the length of time required for immersion has been 10-14 days. The yield of fibre from the bundles shown in Plates V and VI has been from 10.7-11.9 per cent., and fibre of excellent quality has been obtained.

There is, however, much yet to be learnt regarding this plant before it can be recommended to growers in South Africa for cultivation.

The main points deserving of consideration and worth further attention are:—

1. Is there a market in South Africa for this class of fibre?
2. Can the fibre be produced in sufficient quantity and as a payable proposition to supply a local demand or build up an export trade?
3. Of the many varieties of *Hibiscus cannabinus* at present in South Africa, which are the most suitable for cultivation as regards yield and quality of fibre?

The only possibility of establishing a permanent industry with crops of this kind is through the medium of science and careful organization. The scientific botanist is necessary for the study and improvement of the plants in the field, while the technologist is required for the investigation of the fibre in the laboratory.

No results of any value from a field study of this crop could be expected for at least five years, and such an investigation to be properly carried out would require the whole time of one or more qualified investigators.

Hibiscus cannabinus thrives naturally in many parts of South Africa. The crop is an easy one to grow. It produces a heavy yield of fibre of excellent quality. The plant certainly has possibilities, but until these have been thoroughly investigated on scientific lines, it cannot be recommended for trial on a commercial scale. Much has already been achieved from the botanical study of this plant in India, and there is no reason to suppose that similar results could not be obtained in South Africa if the proper organization and machinery were set in motion.

Specimens of *Hibiscus cannabinus L.* and its fibre may be seen on application at the Botanical Laboratories, Pretoria.

The Electro Furnace Products, Limited, whose works are at Germiston, has informed the Department of Industries that they expect to commence the production of calcium carbide commercially during the present month. The initial output will be about 1½ tons per diem, which will be increased early next year. The company is manufacturing their own electrodes, which are 66 inches long and 9 inches in diameter, and it is stated that they will be prepared to supply industries using electric furnaces with any carbons they may require at a cheaper rate than the imported.

It is announced that a national institute is to be established in Italy having for its objects the investigation of the relations between malaria and agriculture, the study of the direct and indirect causes of the unhealthiness of malarial districts, and the organization of a campaign against those causes.

Electro-Chemical Industries.

PROSPECTS AND POSSIBILITIES OF THEIR ESTABLISHMENT IN SOUTH AFRICA.

By H. Bohle, M.V.D.E., M.I.E.E., Professor of Electrotechnics, South African College, Capetown, and C. D. van der Merwe, B.A., Ph.D., Professor of Chemistry, Victoria College, Stellenbosch.

General Remarks.

A very wide range of commercial products are manufactured to-day by means of electro-chemical processes. All require electric power in greater or smaller quantities, and the cost of current is in many cases a large item in the cost-sheet. The power requirements, however, vary considerably for different purposes, and many other conditions have to be considered before a particular industry can flourish in a certain locality.

The current may be used for its chemical effect as in electro-deposition: or for its heating effect as in furnaces; or for both as happens in the electrolysis of fused salts. In addition we have electric discharges through gases.

To-day, the copper output of the world is principally electrolytically refined. Electrolytic nickel is also well known, and zinc and tin so treated are appearing on the market. Silver is separated from gold in this manner and lead-bearing bismuth is successfully worked. Electrolytic refining produces metal of the highest purity, and it renders the recovery of impurities as by-products possible, thereby cheapening the cost of production of some less common materials.

Electrolysis of common salt forms the basis of the electrolytic alkali industry producing caustic soda, on which many industries rest, and which is used for the manufacture of soap, for mercerizing cotton, etc. Metallic sodium, also produced electrolytically, is the foundation for cyanides, so extensively employed in the metallurgy of gold and silver. In addition, chlorates, used for making matches and explosives, hypochlorites for bleaching, chlorine for sterilization, etc., rest on electro-chemistry.

The electric furnace is used for the production of abrasives, such as carborundum, alundum, aloxite, etc.; for graphite, silicon, and especially for ferro-alloys, such as those with tungsten, silicon, maganese, chrome, vanadium; for steel, principally the superior classes, for instance high-speed tool steel, armour plate, etc. For the production of phosphorus (by distillation) and of calcium carbide, employed for producing acetylene gas and cyanamides, we require the high temperature of the electric furnace, which is also of great importance for the production of aluminium.

As regards electric discharges through gases, we have the production of ozone for sterilizing, and of nitric oxide for fertilizers and explosives.

Nearly all these industries are still in their infancy, although considerable progress has already been made in many of them, and artificial products are effectively competing in many instances with natural products. It goes without saying that, where the artificial substance has to compete with the gift of nature, the latter will govern the ruling prices. A case in point is Chili saltpetre, which before the war averaged £9. 7s. 6d. per ton f.o.b. Liverpool. In this cost is included a tax of £3. 3s. imposed by the Chilian Government, as well as a profit of from £1. 1s. to £2. 2s. per ton. In thirty years the Chilian Government netted over 100 million pounds from this tax alone. The annual output of Chilian saltpetre before the war was nearly three million tons, more than half of which was used for the manufacture of explosives.

For every industry enumerated above great quantities of energy are required. For the refining of lead we want 120 kilowatt-hours or units per ton (2240 lb.); for copper 300 units. In nickel refining the figure is about 3000 units, as diaphragms must be employed. Where insoluble anodes are used for the recovery of metals from solutions the power varies from 700 to 4000 units per ton, depending on the metal, current density, and the depolarizing action of the anode.

To manufacture calcium carbide, from 3500 to 4500 units are necessary per ton. For smelting operations, such as the refining of steel or casting alloys, 600 to 1000 units are wanted. For ferro-alloys, which require greater energies on account of endothermic reactions, from 3000 to 8000 kilowatt-hours per ton of product are consumed, according to the grade of alloy. Aluminium requires as much as 25,000 units per ton of metal. In the electric arc method for fixing nitrogen about 15,000 kilowatt-hours are consumed in producing one ton of nitric acid.

From these remarks it will be obvious that the question of cheap power is one of the most important in connection with electro-chemical industries. Next in importance, or perhaps quite as important, is the question of raw materials, after which market and labour questions have to be considered. Electro-chemical industries have chiefly sprung up where power is available at a very low figure. In Norway it is sold at 0.075 penny per unit. We there find installed nearly one million kilowatts, employed chiefly for the fixation of nitrogen. Norway is very fortunate in being able to utilize power in large quantities with a minimum of capital expenditure on account of big falls, a uniform supply, and a country which lends itself to the easy harnessing of water.

Another centre of electro-chemical industries is found near the Niagara Falls, where power is sold at 0.15 penny per unit (1). Such a figure may, in favourable circumstances, be obtained with steam plant, although hardly in this country, where labour and plant are expensive.

It was not so much the price of current as a happy combination of circumstances which placed the electro-chemical industries of North America near the Niagara Falls. The cost of production is largely a matter of freight. Fuel is carried and power is transmitted. Where raw material is bulky and the product and the power are not, the work is best located at the source of the raw material. For industries which

require large power, but comparatively little raw material, the latter is best carried to the work. In zinc metallurgy it takes 3 tons of coal to smelt 1 ton of zinc, so that zinc smelters should be located in the fuel belts. For aluminium, which requires 25,000 units per ton of metal, we naturally carry the raw materials to the works. At the Niagara Falls raw materials for many industries are close at hand, the lakes and rivers make transportation cheap, and labour conditions are good. Moreover, as investments in electro-chemical industries are usually high, it is generally found convenient to make use of existing plant and thereby save the money which would otherwise be required for a separate power station for the industry.

It has been suggested, in order to obtain current at very low rates, that electro-chemical plant be run at periods of light loads. In nearly all cases this cannot be done economically on account of creating undesirable chemical conditions, and because of the loss of heat and the expenditure of additional energy for re-heating, not to speak of the loss of production due to idle hours.

In electro-chemical work the pressure of the supply current is mostly a low one, whereas power is supplied chiefly at high pressures. For electrolytic work this requires conversion by means of transformers and converters, and for furnaces, which employ mostly alternating current, by means of transformers only. The conversion losses further increase the cost of current, and energy sold at 0.2 penny per unit will cost about 0.25 penny before the actual seat of the work is reached.

As regards this country it may be confidently stated that nearly all raw materials required in the above-enumerated industries can be found within the Union of South Africa. Very little is known, however, about the quantities available, except perhaps in the case of coal and gold. Information is also wanted in respect of the chemical composition of the raw materials. Systematic investigation into the resources of this country and reliable chemical analyses of available raw materials are essential before industries on a large scale can be established.

These remarks apply also to the question of water power. Water power of enormous magnitude is available in some parts (e.g. the Victoria Falls, the Orange River falls and rivers in the eastern Transvaal), but authentic information is not yet obtainable. We are glad to hear that the Director of Irrigation has had placed at his disposal a sum of £1000 during the present financial year in order to enable him to make a start in investigating the available water power of the Union.

Coal of fairly good quality is found in abundance in the Transvaal and in Natal. It is also mined in the Orange Free State, near Kroonstad and Heilbron, and in the Indwe District of the Cape Province. The coal in the latter case, however, is of inferior quality.

The Transvaal is fortunate is having the gold mines in such close proximity to the coal pits. We find here the largest electric power stations in the British Empire, and the works of the Victoria Falls Power Company are third or fourth in the list of the largest power stations of the world. The power, however, is sold at a fairly high price, viz., 0.5 penny per unit, a figure which would in all probability be considerably reduced if large industries of an electro-chemical nature were to be added to the gold mining industries. It is not

necessary, however, that for industries supplying South African needs the ruling prices of power should be as low as those obtaining in Europe. All imported articles have to be carried thousands of miles by sea and hundreds of miles per rail before they reach the majority of the consumers, and industries which could not thrive in Europe with current at 0.25 penny per unit might be able to exist here at 0.5 penny per unit. The position, of course, is an entirely different one when a South African industry wishes to compete in markets oversea.

Another important question is labour. The Rand is not an ideal place in this respect, but to a large extent the same may be said of the whole of South Africa. The reason is to be found in the existence of white and black races. The imported skilled workman soon blossoms into an overseer of coloured labour, a process which by no means conduces to efficiency. Moreover, in spite of cheap coloured labour, the total expenditure of labour in this country will always be higher than in Europe. Labour troubles come in addition. In some cases the question of labour may have an important bearing on the selection of the locality for any particular industry.

As regards the market, the white population of the Union is about one and a quarter millions, the natives being about six times as numerous. As customers the latter are probably about equal to the white race, so that we have to reckon with about two and a half million people as far as electro-chemical industries are concerned. This population is roughly equal to that of Birmingham and Manchester, and means a limited market for local industries, inasmuch as they will have to rely almost exclusively upon South African consumption for many years to come. An exception may have to be made in the case of industries which supply the mining and agricultural industries. To-day, cyanides and fertilizers are almost entirely imported and extensive works have been kept going oversea for the South African market. It should be possible to capture this trade to a large extent and to become somewhat independent as regards these materials, which are so essential for the two chief industries of the country, viz., mining and agriculture.

At present practically nothing has been done in the Union in the way of producing goods manufactured electro-chemically, except that a beginning has been made in making shoes and dies for stamp mills, and a factory for the production of calcium carbide is in course of erection. There is no doubt that a good deal can be done locally and at a reasonable cost. With our present lack of knowledge of the power resources of the country, and the fact that a large quantity of electrical energy is available on the Rand, it is there that new industries will chiefly centre. There is an abundance of coal, and lime and iron ore are in close proximity. It is not improbable that a commencement will soon have to be made as regards the manufacture of fertilizers and cyanides, if serious restrictions in the production of gold and of foods are to be avoided. No better time could be found than the present. Prices are enormously inflated and the cost of experimenting will not be felt. Once normal times return the experimental stage will be over and the experience gained in the meantime will enable local manufacturers to compete with the imported article.

It would be impossible to deal with all the various articles connected with electro-chemical industries in the present report. We therefore intend to confine our remarks to a few main articles which

are essential to the gold and agricultural industries of the country, and for which the prospects of local manufacture and of successful competition are good. The first on the list is calcium carbide, which forms the basis for a valuable fertilizer, and the production of cyanide, used in the gold industry. A successful calcium carbide industry is thus the first essential item where the manufacture of fertilizers and cyanides is to be seriously considered.

CALCIUM CARBIDE.

The following table gives the quantities of calcium carbide imported into the Union during the years 1913 to 1916:—

TABLE I.

Year.	Quantity in Tons of 2000 lb.	Value.	Duty, Freight, etc.	Total Value.	Landed Cost per Ton.
		£	£	£	£ s. d.
1916	4,532	52,926	21,136	74,062	16 8 0
1915	5,642	65,751	23,091	88,842	15 16 0
1914	4,912	52,618	16,907	69,525	14 4 0
1913	4,799	46,715	16,216	62,931	13 3 0

The column "Duty, freight, etc.," includes insurance and landing charges. The figures give approximate average values.

To the landed cost must be added inland freight. This varies according to distance, and is £5 per ton of 2000 lb. for a distance of 500 miles. As calcium carbide has been almost exclusively used for the production of acetylene gas we may reckon, on the whole, an average distance of 500 miles before the material reaches the consumer. The total cost thus becomes for 1913, the last normal year, £18. 3s. per ton of 2000 lb. The consumer will, of course, have to pay to the middleman a higher price still, the increase consisting of the profit of the middleman, and the cost of cartage, storage, etc.

The greater part of the carbide imported into the Union up to 1914, inclusive, came from Norway. The proportion was about one-half, whereas in 1915 and 1916 Canada took first place, supplying about three-fifths. Norway during these years came second, Sweden and the United States being third and fourth respectively.

From the table given above it appears that the country requires at present about 5000 tons of calcium carbide at an inland cost of nearly £100,000. If the article is to be manufactured in the Union the furnaces to be installed should finally be capable of coping with this quantity. The requirements will, however, probably be much greater once it is seen that carbide can be profitably made locally without a further increase in the import duty, which stands at 2s. 6d. per 100 lb. for foreign material and 2s. for British carbide, or when fertilizing nitrates can no longer be imported. From calcium carbides it is easy to produce cyanamide, a nitrogenous fertilizer approximately equivalent to an equal weight of sulphate of ammonia.

As will be seen from the tables given below, the Union in 1913 imported manures to the extent of about 60,000 tons, two-thirds of which were superphosphates, while about one-third consisted apparently of nitrates. It will be obvious from this that, if cyanamide can be produced at a reasonable cost, the quantity of carbide required will be very much greater than 5000 tons annually. For this reason curves have been plotted showing the cost of production for 5000 and 10,000 tons per annum.

Undoubtedly a good many difficulties will at first be encountered in the local manufacture of carbide until the raw materials available have been properly tried and labour has become experienced. This should not matter very much at present, since carbide now (August, 1917) sells at a price which allows for experimenting, waste, and profits.

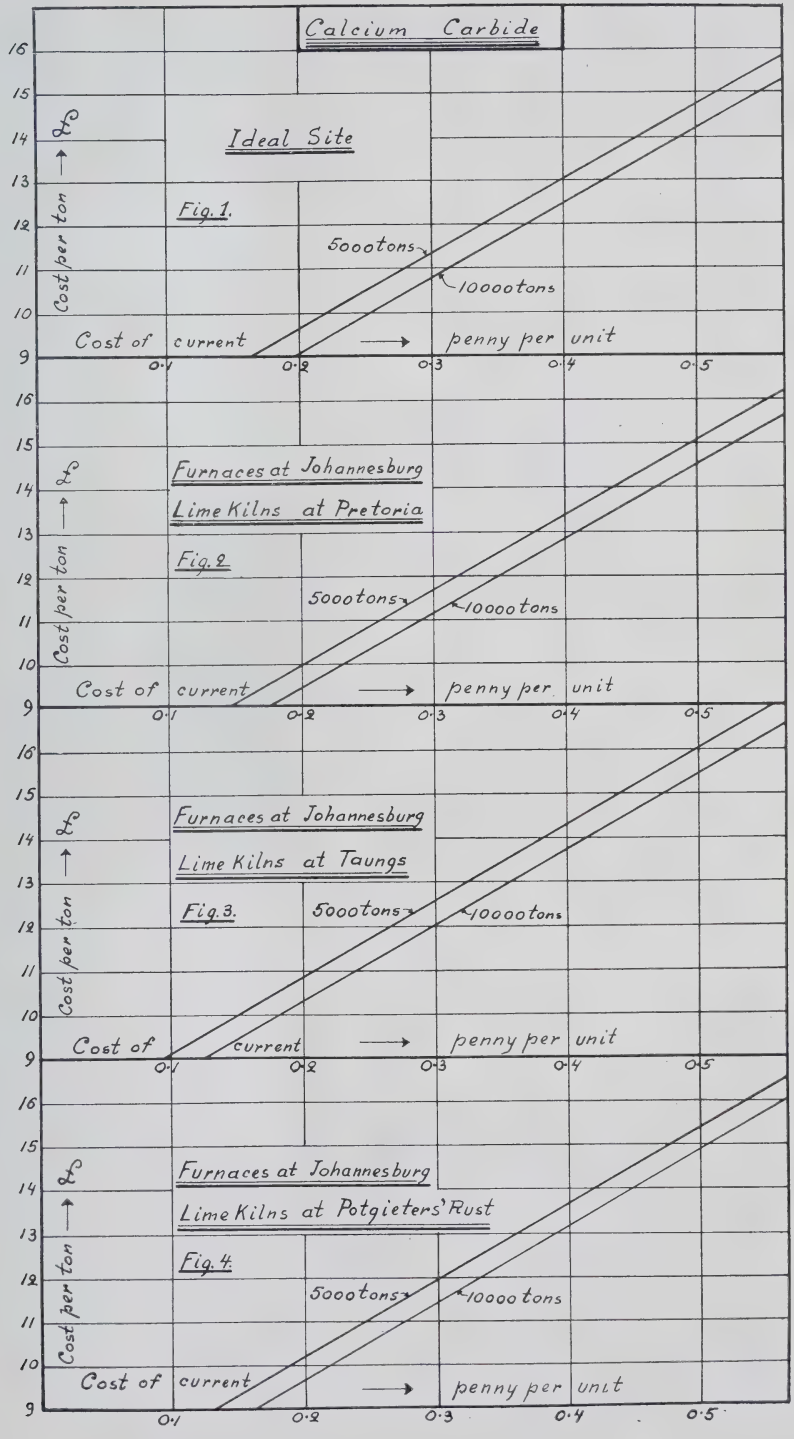
Raw Materials.

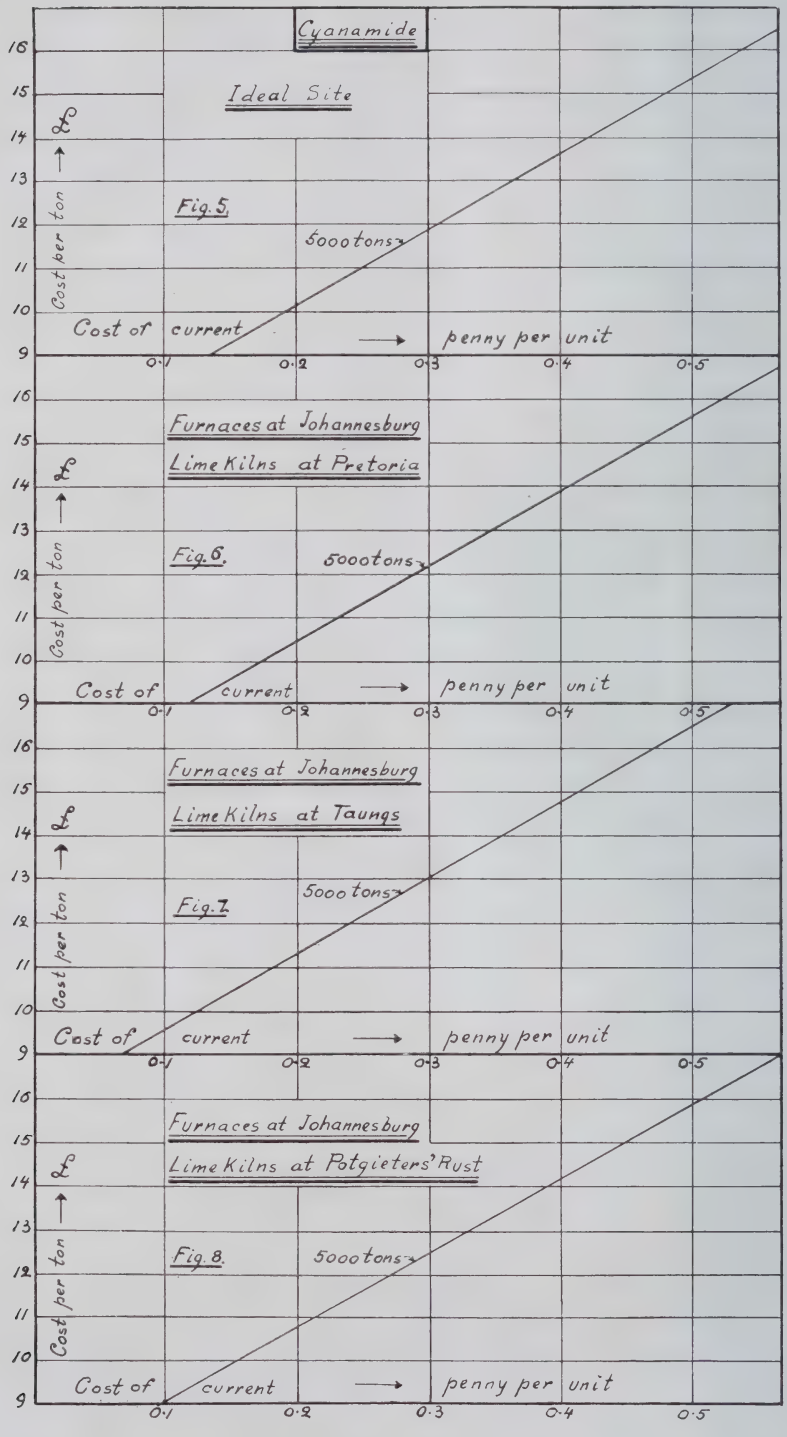
For the production of calcium carbide lime and carbon are needed. Theoretically, we require for the production of 2000 lb. of carbide 1750 lb. of lime and 1125 lb. of carbon. In practice we use at least 1850 lb. of lime and 1320 lb. of carbon to obtain 2000 lb. of commercial carbide, which consists of about 85 per cent. of pure carbide. If anthracite is employed we reckon for moderate sized plants at least 2000 lb. of lime and 1400 lb. of coal. South African coal, being rich in ash and low in carbon (10 to 16 per cent. ash, 60 to 80 per cent. carbon) would require considerably more material, and as the current has to fuse the bulk there would be an increased cost for current. It might pay to instal a washing plant in order to increase the percentage of carbon. With the best coal available in this country we shall have to reckon on about 1700 lb. of coal for producing 2000 lb. of carbide.

South African coal, with the exception of some Natal coal, is on the whole unsuitable for coking. This depends somewhat on the type of oven employed. With ovens into which the coal is introduced under pressure even a fairly lean coal will give dense coke. Coke, however, is not essential. The coal to be used need not be powdered too much, as granulation is better than powdering. Half-inch to three-quarter inch mesh has been found best. The crushing plant may thus be simple. There should be plenty of plant of this class available on the Rand.

One thousand tons of limestone yield theoretically about 560 tons of lime; in practice it is not safe to reckon on more than 450 tons. Hence with 2000 lb. of dry lime per ton of calcium carbide, when employing South African coal of good quality, we require per ton of product 4444 lb. of limestone. To be on the safe side, we shall estimate on 4800 lb. of limestone.

Limestone is found at Pretoria, Potgieters Rust, and Taungs. Non-siliceous limestone is rare in South Africa as far as we know at present. At Potgieters Rust it contains only about 1 per cent. of silica, and at Taungs about 1½ per cent. These should be found very suitable. For highly siliceous limestone it might be possible to follow other countries by adding iron in order to produce ferro-silicon, the carbide being a by-product. Curves are given which show the cost of production for an ideal site, with lime and coal in the vicinity, and


Calcium Carbide
Ideal Site
Fig. 1.
£
Cost per ton
5000 tons
10000 tons
Cost of current
penny per unit
0·1
0·2
0·3
0·4
0·5
9
10
11
12
13
14
15
16
Furnaces at Johannesburg
Lime Kilns at Pretoria
Fig. 2
Furnaces at Johannesburg
Lime Kilns at Taungs
Fig. 3.
Furnaces at Johannesburg
Lime Kilns at Potgieters' Rust
Fig. 4


Cyanamide
Ideal Site
Fig. 5.
5000 tons
Cost per ton £
Cost of current → penny per unit
Furnaces at Johannesburg
Lime Kilns at Pretoria
Fig. 6.
5000 tons
Furnaces at Johannesburg
Lime Kilns at Taungs
Fig. 7.
5000 tons
Furnaces at Johannesburg
Lime Kilns at Potgieters' Rust
Fig. 8.
5000 tons
16
15
14
13
12
11
10
9
0·1
0·2
0·3
0·4
0·5

also for furnaces at Johannesburg and limekilns at Pretoria, Potgieters Rust and Taungs. This is cheaper than bringing the limestone to the electric furnaces, since coal is carried at a lower figure than limestone. Moreover, the bulk carried is less. It means, however, that the managing expenses will be somewhat higher than with all work concentrated. On the other hand, labour should be cheaper at Potgieters Rust and Taungs than at Johannesburg.

For reasons stated above the furnaces have in all cases been placed in the Johannesburg District.

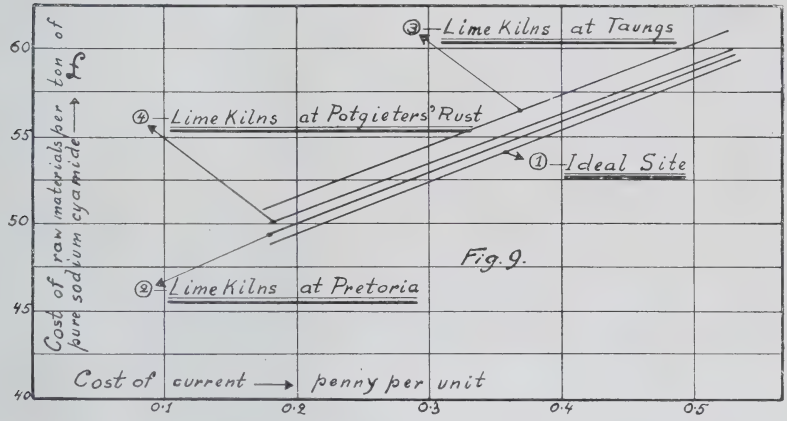


Fig. 9.

The power required for electric furnaces producing carbides differs a great deal, as it depends on the type of furnace used and the mode of manufacture. Theoretically, we require per ton of calcium carbide (of 2000 lb.) 3225 kilowatt-hours for heating the correct mixture of pure lime and carbon to 3300° C. In practice the figures vary considerably, as the following table shows (2):—

TABLE 2.

Power Used in Carbide Furnaces.

Authority.	Power used per Ton of Calcium Carbide.
Lewes	3.410 Units.
Keller	3,500 ,,
Carlson	3,700 ,,
Patten	3,700 ,,
Borchers	3,741 ,,
Keller	3,862 ,,
Lewes	3,916 ,,
Haber	4,023 ,,
Pierad	4,428 ,,
Nikolai	4,560 ,,
Carlson	5,055 ,,
Haber	5,364 ,,

With an up-to-date plant the consumption should not exceed 3600 kilowatt-hours per ton of calcium carbide produced when employing a high percentage carbon anthracite. With South African coal it is not safe to reckon less than 4000 units per ton of 2000 lb.

The consumption depends also somewhat upon the size of the furnaces. In the tables this has been partly taken into account. It is probable that in this country several furnaces of a smaller size will be preferable to one or two very large furnaces.

Coal is reckoned throughout at 15s. per ton of 2000 lb. for the electric furnaces. For the burning of lime a cheaper coal of 10s. per ton is used. These are Johannesburg prices. With limekilns at Taungs and Pretoria freight has been added, the same coal being used. For the limekilns at Potgieters Rust the coal is obtained from Pietersburg.

The manufacture of the electrodes will probably entail at first some experimenting, unless they can be imported. Gas works are, however, available at Johannesburg, and gas retort carbon may thus be obtained. The consumption of the electrodes varies from 30 to 100 lb. per ton of carbide produced, according to the type and size of furnace and charge. One usually reckons about 50 lb. of electrodes per ton. To be safe, 65 lb. have been taken for valuating the cost in this country in order to allow for a somewhat inferior quality.

In all cases 20 per cent. contingencies on the total working costs have been added. This might appear to be too much on the safe side. We consider this advisable, however, rather than placing the manufacture in too rosy a light. This basis has also been adopted in a report on the subject by the Resources Committee of the South African Institute of Electrical Engineers, from which the cost of the plant and cost of labour have been taken. We understand that the cost of plant given there applies to normal times. It is, however, doubtful whether it will be possible to obtain plant at this figure even after the war, and locally made plant will probably cost more. Again, the consumption of current as given in this report must first be proved for the local raw materials. The contingency of 20 per cent. on all costs, including current, should, however, give ample margin to ensure keeping the estimated costs within figures which practice alone can prove.

COST OF PLANT.

The following values have been given by the Resources Committee of the South African Institute of Electrical Engineers:—

TABLE 3.

Capital Cost.

Output per Annum.	5,000 Tons (of 2,000 lb.).	10,000 Tons.
Capital outlay including furnaces, lime kilns, crushers, buildings, etc.	£32,500	60,000
Working capital	12,500	20,000
Total capital required	45,000	80,000

WORKING COSTS.

We have assumed for the next table an ideal site at which coal for the furnaces can be obtained at 15s. per ton, limestone at 5s. per

ton, coal for burning lime at 10s. per ton, and current at 0.3 penny per unit, the figures for the raw materials including all freight charges.

TABLE 4.

Working Costs.

MATERIAL.	ANNUAL OUTPUT IN TONS, 5,000.		ANNUAL OUTPUT IN TONS, 10,000.	
	Total Cost.	Cost per Ton.	Total Cost.	Cost per Ton.
	£	Shillings.	£	Shillings.
Limestone (12,000 and 24,000 tons).....	3,000	12·0	6,000	12·0
Coal at 15s. (4,250 and 8,500 tons).....	3,188	12·75	6,375	12·75
Coal at 10s. (1,800 and 3,500 tons).....	900	3·6	1,750	3·5
Electrodes at £20 per ton, 1,625 and 3,000 tons	3,250	13·0	6,000	12·0
Repairs and maintenance	1,500	6·0	2,500	5·0
Labour.....	5,000	20·0	8,000	16·0
Office expense and general	1,500	6·0	2,000	5·0
10 per cent. depreciation on all plant.....	3,250	13·0	6,000	12·0
Current, 20 million units, at 0·3 penny.....	25,000	100·0	50,000	100·0
Power for crushing.....	650	2·6	1,300	2·6
Total cost.....	47,238	188·95	89,925	179·85
Contingencies at 20 per cent.....	9,448	37·79	17,985	35·97
Grand Total.....	56,686	226·74, or £11. 6s. 9d.	107,910	215·82, or £10. 15s. 10d.

In the accompanying figures 1 to 4 values per ton of carbide have also been given for various costs of current—from 0.2 to 0.5 penny per unit. Figure 1 holds for an ideal site, as given in Table 4. Figure 2 refers to furnaces at Johannesburg and limekilns at Pretoria. Figure 3 gives the costs for furnaces at Johannesburg and limekilns at Taungs, and figure 4 refers to limekilns at Potgieters Rust.

Considering the figures, it will be noticed that the maximum price of commercial calcium carbide with limekilns at Taungs is £16. 1s. 4d. per ton. This price would still be able to compete with the imported article, as it does not exceed very much the landed cost of carbide before the war. There is little doubt that, for some time after peace has been declared, the landed cost of imported articles will be considerably higher than before the war. We would also repeat that the cost-sheet has been prepared not with a view of making the figures appear in a rosy light, but by erring rather on the safe side. We have no hesitation in saying that the prospects of a flourishing calcium carbide industry in this country are extremely good, and we wish the undertaking at Germiston all possible success.

REMARKS ON WORKING.

A few remarks on the industry and what experience has taught may not here be out of place. The furnaces employed are mostly of the smothered type, in which the arc extends from the end of the electrode beneath the surface of the charge, and heating is produced in the charge by arc and resistance heating. The following conditions should be fulfilled:—

(*a*) The electrodes must be able to burn themselves free, so that a space of a few millimetres is produced between electrodes and charge. This is essential, as all materials become conducting at the high temperatures at which fusing takes place. If the charge touches the electrodes, the pressure will drop, the cross-section carrying the current becomes larger and larger, and finally the glowing brickwork commences to conduct (3). We must have a gas film around the electrodes which forms the real hearth of the reaction. This means that the electrodes must hang freely into the crucible. The raw material should be granular rather than powdered, as already pointed out. The powdering is not only expensive but also a direct disadvantage.

Carbon monoxide gas which is formed is prevented from escaping freely by the finely powdered charge. The inner wall of the cavity around the electrodes, on account of the radiant heat from the arc, becomes glazed by the fusion of the lime and its subsequent reaction upon particles of carbon in its immediate neighbourhood. The internal glazed cavity thus formed still further encloses the reaction gases, causing an increase in the pressure of the gas until the walls of the cavity give way and allow a portion of the gases to escape, carrying with it part of the charge in the form of dust. Channels are thus formed, which also become glazed on account of the high temperatures of the carbon monoxide, serving to conduct away from the furnace a considerable amount of heat.

(*b*) The best lining of a furnace consists of a solidified part and slag of the charge. The walls of the furnace should be properly cooled (4).

In order to fulfil these conditions it is best to enlarge the furnace beyond the actual fusing zone. This increases the thickness of the charge which has to be broken up, but with the modern method of doing it by means of an auxiliary arc this has become quite easy. We employ an auxiliary electrode, and with a sufficient current it is possible to break up solid blocks 20 inches thick in as many minutes.

The cooling of the furnace wall may be accomplished with air or, if ferro-silicon is a by-product, with water. The method is commonly employed in the iron and steel industry.

(*c*) Current connections from the bottom, still frequently used, are not very satisfactory. The difficulty lies in making proper connections between the iron containing structure and the carbon hearth. Practice has shown that the efficiency is considerably increased when the crucible is not used as an electrode, but a second electrode is employed. This is also the reason why polyphase furnaces are more efficient, as they distribute the heat better and also because no loss of voltage ensues owing to the resistance of the block of carbide formed (5). It is now also possible to increase the size of the charge considerably. The voltage required varies from 55 to 70, the current from 1000 to 10,000 amperes and more.

The fixed portions of the conducting leads should preferably consist of flat strip copper, 6 to 12 inches wide and up to $\frac{5}{8}$ inch thick. Care must be taken that the induction of these leads is as small as possible.

Both direct and alternating currents may be used, although alternating is preferable, as the secondary of a transformer may be brought into close proximity of the furnace, whereas a direct current generator has to be placed at a considerable distance from the furnace. Otherwise the quality of the carbide is practically the same for both types of currents. Where ferro-silicon is to be produced, alternating current gives the better quality.

The size of the electrodes depends upon the size of the furnace. They are made of a combination of anthracite coal, petroleum coke, graphite and binding materials, requiring great care in order to produce a substance which will withstand the high temperatures and severe strains of electric furnace operation. Practically all electrodes are made with screw joints, so that very little is wasted, the electrodes being fed continuously through the roof. As the contact resistance would cause considerable heat between the carbons and the connections, the latter are often water-cooled. A water jacket is also frequently given to the gland by means of which the carbon passes through the roof of the furnace. The current densities in the carbons vary from 10 to 40 amperes per square inch. The consumption of electrode may be as high as 100 lb. per ton of carbide produced.

The correct measurement of the power used by a carbide furnace is not so simple, as the exact calibration of wattmeters for very heavy currents is not very easy.

The furnaces employed for the manufacture of calcium carbide work either continuously or semi-continuously, or discontinuously. In the former type the work goes on all the time and the loss of power and of production due to idle hours is reduced to a minimum. In the semi-continuous type the work is mostly stopped for a very short time only, during which the hearth is taken away and a new one put in its place. The hearth is then often fixed to a small truck. Provision must be made for proper feeding and for getting rid of the gases produced. In the Siemens furnace the main central electrode is made hollow in order to allow the gases to escape.

A good quality of calcium carbide should produce about 5 cubic feet of acetylene gas per lb. of carbide.

NITRATES, FERTILIZERS, ETC.

The importance of nitrates for these two most important industries of the Union may be gathered from the fact that during 1913 the landed cost of nitrates reached very nearly the sum of one million pounds sterling. During the war the prices have gone up enormously (as the accompanying tables illustrate), except in the case of nitrates employed for the manufacture of explosives. More noticeable still is the great reduction in the importation of fertilizers, the quantities imported in 1916 being far less than half the amount received in 1913. This must have in time a very serious effect on the production of foods in this country, unless substitutes can be found or manufactured locally.

Large as were the quantities imported before the war, there is no doubt that the benefits of a liberal use of fertilizers in this country are still too little understood. What can be done is excellently shown in a publication by the Board of Agriculture and Fisheries, compiled by T. H. Middleton, C.B., at the instigation of Lord Selborne, on "The Recent Development of German Agriculture." In this publication Middleton gives the following summary:—

"On each hundred acres of cultivated land:—

1. The British farmer feeds from 45 to 50 persons, the German farmer feeds from 70 to 75 persons.
2. The British farmer grows 15 tons of corn, the German farmer grows 33 tons.
3. The British farmer grows 11 tons of potatoes, the German farmer grows 55 tons.
4. The British farmer produces 4 tons of meat, the German farmer produces $4\frac{1}{2}$ tons.
5. The British farmer produces $17\frac{1}{2}$ tons of milk, the German farmer produces 28 tons.
6. The British farmer produces a negligible quantity of sugar, the German farmer produces $2\frac{3}{4}$ tons."

These results of the German farmer have been principally obtained through the very liberal use of manures. During the period between 1890 and 1910 the total consumption of artificial fertilizers rose from 1,600,000 to 6,000,000 metric tons; while the use of potash increased tenfold, and the use of basic slag more than threefold. This is the reason why Germany, a country with a comparatively poor soil, and an area of about 80 per cent of that of Texas, is able to raise 95 per cent. of the food consumed by a population nearly 70 per cent. of that of the United States. From the latter country the exportation in ten years of wheat and flour has fallen from 31 to 13 per cent. of the production, and while the population has increased by 21 per cent. the general crop production has only increased by 10 per cent. (6).

Nitrogen fertilizers used to be obtained in the various countries partly from ammonium sulphate of the gas works, from deposits of guano, from kraal and stable manures, and especially from Chili saltpetre. But the supplies from these sources soon proved to be quite inadequate to meet the rapidly increasing demands of agriculture and the modern chemical industries. The consumption of ammonium sulphate in 1913 in the principal countries is given in the accompanying table (7):—

TABLE 5.

Consumption of Ammonium Sulphate.

Country.	Metric Tons.
France	90,000
England	97,000
Japan	115,000
United States	235,000
Germany	460,000

In 1914 Great Britain consumed 106,000 tons and exported 313,877 tons of ammonium sulphate (8).

The approximate consumption of Chili saltpetre in 1910 is given in Table 6 (9).

TABLE 6.

Consumption of Chili Saltpetre in 1910.

Country.	Metric Tons.
Great Britain	100,000
Belgium	200,000
France	250,000
United States	400,000
Germany	500,000

The world's demands for ammonia is increasing at such a rate that, in seven years, it will take almost the whole production possible if all the world's coke were made in by-product ovens. A corresponding increase in coke consumption cannot be expected (10).

It is stated that there are employed in the world's nitrogen fixation industry over 1,000,000 horse-powers day and night all the year round (11).

These few statistics are given in order to show what importance is attached and attention given to this matter in other countries.

With the rapidly increasing demands for nitrates this gift of nature was soon found to be inadequate, and recourse had to be had to the manufacture of artificial nitrogen fertilizers in order to increase the yield on a given area of land and to maintain or improve a certain normal fertility of the soil.

In the chief countries large quantities of ammonium sulphate are now obtained from coal as a by-product of either coal gas or coke manufacture. One hundred pounds of coal yield on an average about 1 lb. of ammonium sulphate from this source. But even this supply, valuable as it is, and added to the Chili saltpetre, could not meet the demands for combined nitrogen. Recourse was then had to the atmosphere overlying the earth.

Over a square mile of the earth's surface about 20,000,000 tons of nitrogen are available. This amount is equivalent to what argiculture and the sciences would require during the next forty years at the normal present rate of consumption. The problem of making this source of supply available has been more or less satisfactorily solved and several successful processes are to-day in actual operation for fixing atmospheric nitrogen in the form of nitric acid, ammonia, cyanamide or cyanide.

POSITION AS REGARDS NITRATES IN THE UNION OF SOUTH AFRICA.

The natural supply of nitrates in this country is insignificent. Several small deposits have been found but proved of little or no commercial importance. The imports of nitrates into the Union will be seen from the following tables:—

TABLE 7.

Nitrate of Ammonia.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	125	8,820	800	9,620	77 0 0
1915	0·4	11	—	—	—
1914	306	7,075	683	7,758	25 6 0

To this must be added nitrates imported for manufacturing purposes, chiefly for explosives, the quantities of which have steadily risen during the last year (1916).

TABLE 8.

Nitrates for Manufacturing Purposes.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	64,394	278,841	140,000	418,841	6 10 0
1915	16,169	112,325	27,000	139,325	5 2 4
1914	25,560	220,511	28,000	248,511	9 14 9
1913	27,258	235,984	29,000	264,984	9 14 0

MANURES.

The following tables strikingly illustrate how the importation of manures has steadily decreased during the last few years, and that a manure "famine" must be contemplated.*

TABLE 9.

Basic Slag.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton. Landed.
		£	£	£	£ s. d.
1916	6,230	20,614	16,700	37,314	6 0 0
1915	9,027	21,029	18,750	39,779	4 8 0
1914	6,832	13,786	6,970	20,756	3 1 0
1913	5,970	11,411	4,600	16,011	2 14 0

* This applies chiefly to phosphates. Nitrogenous manures can be obtained in this country in the shape of guano, whale guano, etc., while hundreds of tons of refuse from fishes are thrown away. Also potash is available as Karroo ash. Phosphates are, however, entirely imported. Further investigations are wanted in connection with phosphorites, which might take the place of phosphates. Neither process nor plant is available for making them soluble.

TABLE 10.

Bone Manure.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	143	905	500	1,405	9 16 0
1915	2,019	8,776	4,150	12,926	6 9 0
1914	4,400	18,293	4,600	22,893	5 4 0
1913	4,714	20,100	3,900	24,000	5 2 0

TABLE 11.

Phosphates (Raw).

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	—	—	—	—	—
1915	—	—	—	—	—
1914	377	1,185	400	1,585	4 5 0
1913	761	1,705	780	2,485	3 5 2

TABLE 12.

Potash Manures.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	—	—	—	—	—
1915	31	672	100	772	25 0 0
1914	714	6,181	800	6,981	9 16 0
1913	2,000	18,107	1,800	19,907	9 19 0

TABLE 13.

Sulphate of Ammonia.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	51	793	180	973	19 1 7
1915	67	788	212	1,000	14 18 0
1914	232	2,408	400	2,808	12 2 0
1913	400	4,707	450	5,157	12 17 9

TABLE 14.

Superphosphates.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	20,000	89,825	44,500	134,325	6 14 5
1915	33,911	110,143	52,000	162,143	4 15 5
1914	36,836	88,103	37,800	125,903	3 8 3
1913	41,013	95,273	40,000	135,273	3 6 0

TABLE 15.

All Other Manures Except Guano.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	3,942	14,504	8,800	23,304	5 18 0
1915	6,548	31,079	1,100	42,079	6 9 0
1914	9,106	45,742	9,600	55,342	6 2 0
1913	8,585	35,233	8,500	43,733	5 1 0

In addition, the following quantities of guano were consumed in the Union :—

TABLE 16.

Guano Sold by the Government.

Year.	Quantity in Tons of 2000 lb.	Value.	Cost per Ton Landed.
		£ s. d.	£ s. d.
1916	6,117¼	45,879 7 6	7 10 0
1915	6,972¼	52,291 17 6	7 10 0
1914	7,076½	35,382 10 0	5 0 0
1913	5,972¼	29,861 5 0	5 0 0

It should be pointed out that the price at which guano is sold by the Government is not the market value, which is about double that given in the table. On the 1st of January, 1917, the price of Government guano was raised to £10 per ton.

In addition there are a number of other local manures marketed.

TABLE 17.

Saltpetre.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	63	3,203	350	3,553	56 6 0
1915	45	1,953	250	2,203	49 0 0
1914	56	1,351	250	1,601	28 12 0
1913	132	2,605	350	2,955	22 8 0

Practically nothing has been done in this country in the way of manufacturing nitrates for manuring. The by-products of the coke industries in Natal are allowed to go to waste. At the same time we do not wish to consider the question of how much ammonium sulphate could be produced for agricultural and chemical purposes if all the coal mined in the Union were distilled or coked before use as fuel, nor whether such a course would be profitable to the industries concerned.

It is sufficiently clear that the available sources of combined nitrogen within the Union will scarcely be able to meet even a small fraction of the country's demand for fertilizers. It is our opinion, therefore, that plants should be put up for the fixation of nitrogen in a locality where conditions are most favourable. Reasons have been given above why at present the Rand is the only suitable locality.

The fact that calcium cyanamide can be prepared directly from atmospheric nitrogen, that it has a fertilizing value nearly (if not fully) as good as ammonium sulphate, and that the only raw materials required for its production are coal, lime, and nitrogen, seems to indicate the lines along which an attempt should be made to manufacture our supply of combined nitrogen

The production of nearly pure nitrogen from the air has been successfully solved, so that the economical production of cyanamide depends entirely on the manufacture of a high-grade calcium carbide and on electric power at a low cost.

MANUFACTURE OF CYANAMIDE.

The fixation of nitrogen by the cyanamide process depends upon reactions that are generally expressed by the following equation:—

$$CaC_2 + N_2 = CaCN_2 + C.$$

Hence, theoretically, 800 tons chemically pure carbide and 350 tons of nitrogen give 1000 tons of cyanamide and 150 tons of carbon. In actual practice and under favourable conditions we reckon 1800 tons of commercial carbide and 400 tons of nitrogen to give 2000 tons of commercial cyanamide of the following approximate composition:—

57-63 per cent. cyanamide (20 to 22 per cent. nitrogen), 20 per cent. lime.

7-8 per cent. silica, alumina, ferric oxide, 14 per cent. carbon as graphites.

In some cyanamide works the nitrogen is obtained by passing the air over heated copper turnings and by subsequent reduction of the copper oxide by means of reducing gases. More commonly the nitrogen is obtained by the fractional distillation of liquid air in a Linde or Claude apparatus. The nitrogen so produced is practically pure and contains only about 0.4 per cent. of oxygen. The nitrogen must be free of carbon monoxide, carbonic acid, oxygen, and water.

The carbide is finely ground in an air-tight apparatus. (The mechanical condition of the carbide largely influences the yield.) It is then filled into drum-shaped retorts, which are constructed of perforated iron to allow an easy passage for the nitrogen and are enclosed in a jacket of refractory material. In the centre of each drum is a carbon rod with electrical connections employed as a heating resistence. After filling, the drum is closed air-tight. A series of such drums is then placed into a long horizontal chamber, the terminals of each drum are connected with the supply current, and the doors of the chamber are closed air-tight. Connection is now made with the reservoir of nitrogen and a constant supply is maintained. The pressure is controlled by means of a pressure gauge. After the air has been displaced by nitrogen the current is turned on from a source of about 75 volts, when the absorption of nitrogen rapidly commences.

At a certain stage the current is turned off, as the reaction, which is strongly exothermic, is able to proceed to completion without any further application of heat, until the absorption of nitrogen is complete, as shown by the pressure gauge. The time of absorption is from thirty to forty hours. The drums are then withdrawn and allowed to cool. The black, sintered contents, which occupy a smaller

volume than the original carbide, are readily removed, ground, and packed in sacks.

The amount of nitrogen absorbed varies largely with the grade of carbide employed, the purity of the nitrogen supply, the temperature, and the time of absorption.

The active absorption of nitrogen begins at 1000° to 1100° C. Above 1360° the reaction is reversible, the cyanamide recombining with the carbon to form calcium carbide and nitrogen. For this reason externally heated furnaces are no longer employed, the control of an electric furnace being so much easier. An essential feature of the manufacturing operation is also the starting of the reaction between the carbide and the nitrogen in the centre of the carbide charge. Nitrogen enters at all points in the outer layer and is drawn towards the centre to replace the amount absorbed.

USES OF CYANAMIDE AS A FERTILIZER.

The world's production of cyanamide in 1906 was 500 tons; in 1914 it was 208,000 tons, which means an increase of about 200 per cent. per year (12). All over the world factories are springing up for manufacturing this valuable article. In England a company with a capital of two million pounds has been founded in order to manufacture nitric acid from ammonia, the latter being derived from cyanamide (13). In Scotland and Ireland plants have been projected which will yield many thousands of tons of nitric acid. Similar activity is shown in Japan and America (14).

There was at first much uncertainty as to the exact value of cyanamide as a fertilizer. Moreover, certain physical and chemical properties of the material caused prejudice against its use. The product can be treated, however, so as to form little or no dust and to be only slightly hygroscopic or to neutralize the lime. It must be admitted that even then it is less pleasant to handle than either sodium nitrate or ammonium sulphate.

Extensive field experiments carried out in European countries have clearly proved that the nitrogen in the cyanamide is readily converted into nitrates suitable for assimilation by plant organs. Bacteria, however, are necessary to bring about the changes to nitrates. Hence it yields excellent results on soils rich in humus and comparatively poor results on acid soils.

The British Imperial Institute expressed the opinion in 1911 that cyanamide is practically equivalent in manurial value to ammonium sulphate on all fairly good soils, but gives less satisfactory results on poor moorland or sandy soils.

In France, Professor F. Laurent in 1909 and 1910 secured data from a group of planters relating to the application of different nitrogen fertilizers in the cultivation of oats. The average increase in the value of the oat crop per acre, after deduction of the cost of the fertilizer, was as follows:—

With sodium nitrate	£1	15	9½
With calcium nitrate	1	6	8½
With ammonium sulphate	1	6	10½
With calcium cyanamide	2	1	3

Professor J. Hendrick, during the years 1905 to 1910, at the Aberdeen and North of Scotland College of Agriculture, carried out

extended and valuable field experiments on the relative effectiveness of calcium cyanamide and sodium nitrate as fertilizers. The results of these tests show in a very conclusive manner that, when properly applied, cyanamide possesses a manurial value for cereals nearly equal to that of ammonium sulphate.*

COST OF PRODUCTION OF CYANAMIDE.

For the production of one ton of 2000 lb. of cyanamide we require 1800 lb. of commercial calcium carbide and 400 lb. of nitrogen, hence for the manufacture of 5000 tons of cyanamide we must have 1000 tons of nitrogen and 4500 tons of carbide. The cost of production at Odda is as follows (15):—

1800 lb. of calcium carbide cost	£3	3	9
400 lb. of nitrogen cost	0	2	6
Labour cost	0	12	6
Current cost	0	4	2
General expenses cost	0	9	3
Total cost per ton of cyanamide ...	£4	12	2

It will be obvious that in this country the cost of production will be greatly in excess of that at Odda. The following tables and curves have been worked out—on the basis of a 5000 ton production per annum—of the cost of carbide as given in figures 1 to 4 under the column containing the figures for an annual production of 10,000 tons of calcium carbide. The capital outlay for such a plant will be about as follows:—

TABLE 18.

Capital Cost for Producing 5000 Tons of Cyanamide.

	£
Furnaces, pipes, crusher plant, buildings, etc.	10,000
Plant for producing nitrogen	4,000
Working capital	3,000
Total	£17,000

TABLE 19.

Manufacturing Costs.

	£
Labour and maintenance	4,200
Office expenses and management	1,250
Depreciation of 10 per cent. on plant of £14,000	1,400
Together	6,850
Contingencies, 20 per cent.	1,370
Total cost of labour and maintenance	£8,220

To these costs must be added the cost of the carbide and of the current for heating and for the production of nitrogen.

For heating the cyanamide furnaces and driving the grinding machines we may reckon about 250 units of electricity per ton of the product, or a total of 1,250,000 units for 5000 tons of cyanamide. If

* For further information and references *vide* Report by Dr. Ch. Juritz.

we reckon 20 per cent. contingencies we obtain 1,500,000 units, costing £1250, £1875, £2500, £3125 at 0.2, 0.3, 0.4, and 0.5 penny per unit respectively.

For 5000 tons of cyanamide we require 1000 tons of nitrogen. Allowing 20 per cent. waste and reckoning again 20 per cent. contingencies, we obtain 1440 tons of nitrogen, costing £552, £828, £1104, and £1380 at 0.2, 0.3, 0.4, and 0.5 penny per unit respectively. On this basis figures 5 to 8 have been plotted, which are self-explanatory.

CYANIDES.

On fusing commercial cyanamide with common salt it forms a product chiefly calcium cyanide, containing about 30 per cent. of sodium cyanide. Metallurgists state that it can be used directly and without difficulty for the extraction of gold. There would seem to be a distinct field for this product in South Africa.

Pure sodium cyanide is obtained by treating the calcium cyanide with sulphuric acid, whereby hydrocyanic gas is set free. By passing this gas into a solution of caustic soda pure sodium cyanide is obtained.

In order to produce a ton of 2000 lb. of pure sodium cyanide we require about 1750 lb. of caustic soda, costing £13; 2100 lb. of sulphuric acid costing £15; 2850 lb. of common salt at £3. 5s.; and 2500 lb. of fuel at £1; making a total of £32. 5s. To these raw materials we must add 3400 lb. of cyanamide, for which the expenditure is given in figures 5 to 8. The total cost of the raw materials will then be expressed by figure 9. If we take curve 2 and reckon 0.4 penny per unit for current the cost of the raw material amounts to £56. The landed cost of sodium cyanide in 1913 was £70. 10s., which means about £75 on the Rand, leaving a margin of £19 per ton of sodium cyanide for interest on capital outlay, depreciation of plant, and operating and maintenance charges, a sum which should be sufficient. Actual figures as to the cost of plant and operating expenses were not available.

TABLE 20.

Importation of Sodium Cyanide.

Year.	Quantity in Tons of 2000 lb.	Value.	Freight, etc.	Total Value.	Cost per Ton Landed.
		£	£	£	£ s. d.
1916	5,221	445,348	40,000	485,348	93 0 0
1915	5,937	504,061	25,000	529,061	90 0 0
1914	5,042	372,430	13,700	386,130	76 12 0
1913	5,797	395,639	14,100	409,739	70 10 0

As most of this material is used on the gold mines the cost of railage from the coast to Johannesburg must be added. The column

under freight includes insurance and landing charges. The figures must be considered approximate only.

Cyanide of potassium was imported to the extent of a few tons only.

Ammonia and Ammonium Sulphate.

These articles can be readily obtained from cyanamide, and the manufacture on a large scale of ammonium sulphate from cyanamide has been organized in Italy, Japan, Germany, and other countries.

The ammonia may further be oxidised to nitric acid by the Oswald process, which is also applied on a large scale.

Dicyandiamide.

This substance is obtained by simply extracting cyanamide with hot water.

$$2\ Ca\ CN_2 + 4\ H_2O = 2\ Ca\ (OH)_2 + (CN\ NH_2)_2$$

The compound is procured in a pure form by crystallization. It contains 66.6 per cent. of nitrogen, and is readily converted into technically pure cyanide by fusion with alkali carbonate and carbon.

$$(CN\ NH_2)_2 + Na_2CO_3 + 2\ C = NH_3 + 2\ NaCN + H + 3\ CO + N$$

Dicyandiamide is now regularly added to various nitro-explosives in order to lower the temperature of combustion.

Under the name of "Ferrodur," cyanamide is also used in connection with the manufacture of machine tools, drills, armour plates, etc.

It is thus unquestionable that the cyanamide industry will have a bright future.

IRON AND STEEL.*

History has shown that the progress of a State stands almost in direct proportion to its iron and steel industries. There is no doubt whatever that the power of Great Britain rests to a large extent upon its iron and steel works, and that the United States would not have a population of over a hundred millions if it had to import its iron and steel goods. We feel sure that in the future development of South Africa iron and steel will play an important part.

At present very little has been done in the way of manufacturing steel in this country, and no pig iron whatever is produced. Steel works have been erected at Vereeniging, in the Transvaal, where standards for fencing and light rails are manufactured, but the total output does not reach 2000 tons per month, and very large sections cannot be produced. Only scrap material is employed at the present day.

Steel shoes and dies are made for stamp mills in an electric furnace at Johannesburg. The output of this furnace may ultimately reach 75 tons per month. At present it is about 60 tons. It means that this furnace can supply about 10 per cent. of the yearly requirements of shoes and dies on the Rand. The cost of the imported article before the war was about £18. 10s. To-day the figure stands at £35.

* The writers are largely indebted to Professor Stanley for the information given under "Iron and Steel."

The locally made article is sold at £27. 10s. per ton, and then on the basis of quality. If, however, the material lasts longer than the imported goods only the full value is paid.

At these figures the furnace is able to pay its way and to make a little profit as well. This is quite remarkable, and is chiefly due to the untiring work of Professors Buchanan and Stanley, who designed and supervised the erection of the plant and look after the working of it. Careful carbon analysis is made of every cast, and about once a month a complete analysis is undertaken. The whole equipment, which includes electric plant, furnace and pre-heating oven, building, etc., cost only about £5000, a very low figure indeed, and rendered possible by the utilization of old electrical plant ready to hand. It had, however, to be partly rewound.

The furnace, which is of the induction type, takes a charge of about 2000 lb. and yields a cast of about 1700 lb. There are usually three casts a day. The furnace uses roughly 1000 units per ton of metal produced.

It will be seen that the furnace is a very small one, but that good results are nevertheless obtained. There is little doubt that the cost of production could be materially reduced with plant several times larger and with more up-to-date methods of handling the material. At present the method of filling the moulds is rather crude. We feel sure that with a large modern plant all the shoes and dies wanted in this country could be manufactured locally at a competing cost even in normal times.

What applies to shoes and dies holds also for many other steel goods. The popularity of the steel furnace is steadily on the increase. The output of electric steel in the United States has increased from 55 tons in 1908 to 175,000 tons in 1916. In the current year the output will probably exceed 300,000 tons. The United States Steel Corporation is building a furnace with an output of 4000 tons per week. In Sweden there are ten furnaces with an output of 130,000 tons of pig-iron per annum. Germany produced in 1916 225,000 tons of electric steel. The total number of furnaces in use at the present day is about 550, against 303 in 1915.

The great advantage of the electric furnace lies in the fact that the temperature can be so easily controlled and that the product is not contaminated by waste gases, and, where the induction furnace is employed, not even by carbon.

The importance of iron and steel goods in South Africa will be seen from the following tables:—

TABLE 21.

Iron and Steel Goods Imported by the Mines in 1913.

Articles.	Tons.	Value.
Bolts, nuts, washers, rivets	2,394	£57,309
Iron castings	4,248	102,863
Pig iron	500	4,900
Iron, bar and angle	4,819	79,504
Rails, crossings, and sleepers	—	250,908
Steel, hand and rock drills	5,633	162,729
Shoes and dies	7,500	135,516
Total		£793,729

TABLE 22.

Total Imports during 1913 *of Iron and Steel Goods.*

Articles.	Value.
	£
Iron and steel, raw or partly manufactured	946,275
Hardware and cutlery and N.O.D.	1,704,241
Fencing material	593, 542
Machinery except locos	2,842,597
Railway and tramway material	308,110
Total	£6,394,765

It will be many years before all these articles can or will be made in South Africa, but we believe that a good deal could be done in this country if the matter were taken in hand properly. Especially in the way of agricultural and mining machinery, and in appliances for water boring, much more might be done than is accomplished at present. The agricultural machinery cost £200,000 oversea; mining machinery over £829,615; water-boring appliances £37,353; and apparatus not otherwise described (n.o.d.), including parts, £937,599. The landed cost of all this machinery is at least 2½ million pounds.

Professor Stanley, in a paper prepared for the S.A. Association for the Advancement of Science in 1917, suggested that the articles given in the accompanying table ought to be made locally:—

TABLE 23.

Articles which might be Made in South Africa.

Articles.	Value.
	£
Agricultural machinery	50,000
Mining and water boring	200,000
Machine parts	100,000
Fencing material	60,000
Hardware, axles, screws, nuts, bolts, rivets, etc.	120,000
Rails and sleepers	100,000
Raw and partly manufactured	400,000
Total	£1,030,000

One or two large blast furnaces could furnish all the pig-iron wanted in this country. Most would be converted into steel in the basic open hearth furnaces. A further portion would be treated in electric furnaces for refined steel, mining drills, machine tools, shoes and dies, etc.

It must again be pointed out that the necessary raw materials are available, but that too little is known about their composition and quantities. In the Pretoria District there is a seam of siliceous iron ore from four to twenty feet thick and many miles long. One ridge south of Pretoria, which can be mined by open cuts and adits, is

estimated to contain four million tons of ore assaying 45 per cent. in iron, or more. Professor Stanley gives the following analyses:—

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Silica (SiO_2)	14·3	17·93	22·1	17·41	21·96
Ferric oxide (Fe_2O_3)	76·93	73·81	63·75	69·43	65·57
Alumina (Al_2O_3)	7·20	7·31	10·41	7·38	6·54
Lime (CaO)	undet.	undet.	0·62	0·75	1·20
Magnesia (MgO)	undet.	undet.	undet.	0·47	0·44
Sulphur (S)	0·03	0·03	undet.	0·014	0·014
Phosphorus (P)	0·14	0·17	undet.	0·17	0·24
Iron (Fe)	53·9	51·8	44·6	48·6	45·9

There is also a persistent bed of "clay-band ore," which outcrops for several miles, about two feet thick, for which Professor Stanley gives the following composition:—

> Silica, 7.70 per cent.; ferric oxide, 73.57; alumina, 7.94; lime, 0.45; magnesia, 0.33; sulphur, 0.029; phosphorus, 0.52; iron, 51.5. If the latter ore is mixed with the above siliceous ore the amount of limestone flux required will be considerably reduced, and not more than 15 to 20 per cent. will be wanted.

Iron ores are also found in the District of Maritzburg; this ore being low in silica (5 to 10 per cent.) and asaying 45 to 60 per cent. of iron according to Dr. Hatch. Prospectors say that the seam is 2 to 5 feet thick and 30 miles long. The ore is rather rich in phosphorus (0.2 to 0.5 per cent.).

As regards the flux, non-siliceous limestone seems to be scarce in South Africa. The limestone found at Taungs and Potgieters Rust should, however, be found suitable. It might also be found possible to use dolomite, which in some cases is low in silica.

For the production of iron, coke is used all over the world in preponderating quantities as mentioned above. South African coal, except some in Natal, is not suitable for coking. Hence Natal is the only Province where we find a coking industry. The by-products, however, are allowed to go to waste. There are many steel and iron works which use no better coke than that obtained in Natal, but at present the local coke is very expensive on account of the small amount produced and the running to waste of the by-products. Further investigations are also wanted as regards coal found in other parts of the country in order to find out their suitability for coking purposes.

The iron industry is not, however, solely dependent upon coke. The best brands of iron are produced with charcoal, and there should be plenty and to spare of this commodity in this country. Mr. Sim, in his paper on the wattle industry, says that 200,000 tons of wattle timber are burnt to waste per annum. This quantity would produce 80,000 tons of charcoal plus many by-products. One ton of charcoal produces roughly one ton of pig-iron. Charcoal iron always commands the highest prices.

Besides coke and charcoal there is still coal to fall back upon. In Scotland they use it as a blast furnace fuel, when tar and ammonium sulphate can also be recovered. The local coal is, however, somewhat rich in sulphur.

Existing works in the Transvaal can produce all the refractory material wanted.

CONCLUSION.

In concluding the present report, we are aware that it is very incomplete and that it touches only the fringe of the subject. The time at our disposal was, however, too short, especially as it fell into the busiest part of the college session. It was impossible to collect further information from oversea as regards costs of plants and operating expenses. The report should, nevertheless, arouse an interest in industries on which the progress of the country in the future will considerably depend.

The following summary indicates the lines along which we consider the work in connection with electro-chemical industries should proceed:—

1. Proper investigation into the quantities and reliable chemical analyses of the mineral resources of this country, especially as regards iron ore, lime, and coal.
2. Exhaustive tests of the coking qualities of South African coal.
3. Thorough investigations of the water power of the Union.
4. Reliable tests of the fertilizing qualities of various manures as regards South African soils.
5. Encouragement of the calcium carbide industry which is being introduced at Germiston in the way of tests and advice as far as these can be rendered.
6. Further investigations into the prospects of a South African iron and steel industry. No country can aspire to greatness without such an industry.
7. Scientific organization of all industrial research. An exhaustive report on this is urgently needed.

BIBLIOGRAPHY.

1. L. Addicks, Electro-chemical Industries and their Interest in the Development of Water Power. *Proc. Am. Institute of Electrical Engineers*, Vol. 35, No. 5, p. 534.
2. J. Wright, Electric Furnaces and Their Industrial Applications. Constable, London, p. 104.
3. Ditto, p. 68.
4. *Elektrotechnische Zeitschrift*, 1909, p. 529. *Stahl und Eisen*, 1908, p. 793.
5. Modern Electric Practice, Vol. 5, p. 262.
6. Washburn: The Facts in the Nitrogen Case, 1916. Statement before Senate Committee on Agriculture and Forestry, 1916.
7. *Zeitschrift des Vereins Deutscher Ingenieure*, 1914, pp. 58, 980.
8. *Metallurgical and Chemical Engineering*, 1915, 13, p. 638.
9. Lamy: *Metallurgical and Chemical Engineering*, 1911, pp. 9, 99.
10. Tuftz: *Journ. Industrial and Engineering Chemistry*, 1911, 3, p. 295.
11. Washburn: Statement before Senate Committee on Agriculture and Forestry, 1916.
12. *Kubierschky: Journ. Industrial and Engineering Chemistry*, 1914, 6, p. 692.
13. *Metallurgical and Chemical Engineering*, 1913, 11, p. 438.

14. *Times'* Engineering Supplement, October 15, 1913.
15. Norton: Utilization of Atmospheric Nitrogen. Special Agents Series, No. 52. (This is an excellent summary of the state of the nitrogen industry.)
16. For the fixation of nitrogen by the arc process we refer especially to Vol. 34, No. 3, 1915, of the *Proc. Am. Institute of Electrical Engineers.*
17. Electric Furnaces in the Iron and Steel Industry are exhaustively treated in the treatise by Rodenhausen and Schoenawa, translated by Vom Baur. (J. Wiley & Sons.)
18. The Sterilization of Water by means of Ozone is explained in a paper by H. Bohle. (*Proc. S.A. Soc. Civil Engineers,* Session 1912.)
19. Iudustrial Nitrogen Compounds and Explosives, by Martin and Barbour. (Crosley, Lockwood & Son, 1915.)
20. Electric Furnace Manufacture of Steel Shoes and Dies on the Witwatersrand, by Professors Stanley and Buchanan. (*Jnl. Chem. Met. and Mining Soc. of S.A.*, pp. 71-87, Vol. XVIII.)
21. Electro-Chemical Industries. (S.A. Inst. of Electrical Engineers, January, 1916.)

Dominions Royal Commission.

INDUSTRIAL POSSIBILITIES OF SOUTH AFRICA.

III.

The following are further extracts from the Final Report of the above Commission:—

Control, Conservation, and Development of Natural Resources.

Having dealt with the productivity of the self-governing Dominions, the Commission proceeds to review briefly the action adopted by the Imperial Government and the Dominions Governments during the war in developing and controlling their resources for the common benefit.

"The success of the action achieved," says the Commission, "suggests that it is expedient that the various Governments of the Empire should take steps, as soon as conditions permit, to secure the development and utilization of their natural wealth on a well-considered scheme directed towards a definite and recognized object. In our opinion it is vital that the Empire should, so far as possible, be placed in a position which would enable it to resist any pressure which a foreign Power or group of Powers could exercise in time of peace or during war in virtue of a control of raw materials and commodities essential for the safety and well-being of the Empire, and it is towards the attainment of this object that co-ordinated effort should be directed.

"Before any adequate measures can be taken towards this end, a preliminary survey is needed of the relation between Empire production and Empire requirements throughout the whole range of articles needed for the sustenance and well-being of the people, for the maintenance of industry, and for the production of munitions of war. So far as we know, such a survey has never yet been undertaken."

The report continues:—

"The experience of the present war has shown that important industries satisfying military and other vital requirements are dependent on many materials, the trade in which is relatively small and the imports and exports of which are not recorded in the official returns. For example the United Kingdom trade returns, contain no record of the imports of nickel or tungsten ore. We regard as urgent a survey on a wider and more precise basis.

"The result of a full survey should divide the necessary materials of trade and commerce into three main categories:—

"(1) *Materials of which the world's requirements are mainly or wholly produced within the Empire.*

"(2) *Materials of which the Empire's requirements are approximately equalled by Empire production.*—A sub-division of this class embraces certain raw materials which are produced in sufficient quantities within the Empire, but which have been sent in the past to foreign countries for treatment or refining before final utilization.

"(3) *Materials of which the world's requirements, and with them those of the Empire, are now mainly produced and controlled outside the Empire.*

"Obvious and simple as a classification on these lines may appear, no systematic and scientific attempt has ever been made to apply it to the various foodstuffs and raw materials required by the Empire. The distinctions which we make are, of course, not absolute, nor are the classes divided from each other by any rigid limits; important articles may occupy an intermediate position between some of the classes. Further, the development of new sources of supply and the progress of industrial discovery may cause frequent transitions from one class to another. The position therefore cannot be regarded merely statically. It should be the duty of some body or department to collect from year to year information as to the requirements of the Empire in respect of all commodities essential to its development, safety and well-being, and as to the output actual and potential, and to watch carefully any tendencies towards change. Action of this kind lies at the root of any endeavour towards a wise utilization of the resources of the Empire, and it should, in our opinion, form one of the most important duties of the Imperial Development Board whose creation we propose in a later chapter of this report."

As regards the materials of which the world's requirements are mainly or wholly produced within the Empire, the Commission remarks:—

"We doubt whether it was realized before the war, that the Empire had substantially a monopoly of the world's production or distribution of certain most valuable commodities of commerce. Even if the fact were dimly recognized no effort had been made by the Governments of the Empire individually, or in co-operation, to use these commodities to their commercial advantage.

"Canada produces much the largest proportion of nickel, cobalt, and asbestos, and, in conjunction with India, of mica.

"New Zealand produces practically the only supply of kauri gum and phormium fibre.

"The Union of South Africa has the virtual monopoly of diamonds and ostrich feathers.

"India has a monopoly of jute, whilst the West African Colonies yield the major portion of the world's supply of palm

nuts and palm kernels, and the Eastern Colonies of plantation rubber.

"The British Empire produces about 40 to 45 per cent. of the world's total supply of wool. If merino wool only is taken, the proportion is much higher. The Empire also produces over 60 per cent. of the world's output of gold.

"It is probable that in the case of articles falling within this category no extraordinary measures are necessary to stimulate production. The Empire's needs are fully met, and a large export trade is carried on with the outside world. It is not difficult, however, to imagine conditions, even in times of peace, in which it might become desirable to use the possession of these assets as an instrument of commercial negotiation. The practical monopoly of potash which Germany possesses has enabled her to exert pressure on other countries in the past, and the controversy between Germany and the United States in 1911 may be mentioned as an example of the influence which the possession of a raw material monopoly gives in commercial negotiations between two Powers. The possession of assets such as the Canadian asbestos and nickel supplies could be used by the British Empire as a powerful means of economic defence.

"We desire, however, to point out that although Canada is practically the only producer of raw asbestos on a large scale in the world, the United Kingdom is largely dependent on outside sources, especially the United States, for the manufactured asbestos which it requires; even Canada imports manufactured asbestos to the average value of £70,000 a year. We draw the attention of the Canadian Government to this position, as it seems to us that a large and important industry in the manufacture of asbestos might be developed in the Dominion.

"Similarly Canada produces about three-quarters of the world's supply of nickel; before the war, however, the refining of the metal was, as we have seen, carried on entirely outside the Dominion, the matte produced by the International Nickel Co. being shipped largely to the United States for that purpose, whilst that produced by the Mond Nickel Co. was sent to South Wales. The control of a large part of the Canadian deposits by a United States company, and the manufacture by the latter of nickel and nickel alloys, gave rise to considerable agitation in Canada after the outbreak of war. The Canadian Government has, as we have shown, taken action to avoid the dangers which might arise from foreign control of the use of nickel ores, and measures have also been taken to secure the erection of refineries in the Dominion. The maintenance and development of this policy seems to us essential in the interests of the Empire."

With regard to materials of which the Empire's requirements are approximately equalled by Empire production, these embrace many staple foodstuffs and commodities of which the production is widespread both in the Empire and elsewhere. In many cases the position is that whilst the Dominions are self-supporting, the United Kingdom is not. Wheat, meat, butter, wool, and cheese are examples of this kind.

The Commission's remarks under this heading are given *in extenso* as follows:—

"In the case of wheat the relation between Empire supplies and Empire requirements varies from year to year with the changing yields of crops, especially in Australia and India, where marked fluctations occur. On the whole the production of wheat within the Empire appears to have been in recent years slightly less than its consumption.

"For its meat supplies the United Kingdom is forced to draw more largely on foreign countries, especially South America. There appears to us to be clearly a case for the further stimulation of cattle breeding, sheep raising, and the keeping of pigs not only in Great Britain and Ireland but in the Dominions, more particularly in Canada, where these industries are at present little developed, and, in our opinion, steps should be taken to encourage the shipment of pedigree stock from the United Kingdom to the Dominions. At the present time the United Kingdom exports cattle and sheep for breeding to the Argentine Republic in larger quantities than to all the Dominions put together. Under its mail contract with the Union of South Africa the Union-Castle Mail Steamship Company undertakes to carry pedigree stock free of freight from the United Kingdom to South Africa. This provision, as we showed in our Third Interim Report, has been attended by excellent results, and we should be glad to see similar clauses inserted in other mail contracts which may be concluded in the future.

"We desire also to emphasize that, in our view, temporary measures of control will be required on the termination of the war in connection with the meat supply, etc., from the Dominions. Owing to the depletion of live stock resulting from the war there will be a shortage of beef, mutton, butter, and cheese over a large part of the continent of Europe, and unless special action is taken there may be a risk that Australian and New Zealand supplies will be diverted. We believe, therefore, that it would be sound as a temporary measure to continue the policy of Government control of refrigerated space in vessels trading to the United Kingdom from Australia and New Zealand. We would also lay stress on the need for care in the various parts of the Empire to guard against depletion of their stocks of breeding cattle.

"We think also that, as a matter of broad policy, it is desirable that the Empire should make such arrangements within itself, as shall secure that the surplus of the Dominions' supplies of the articles we have already mentioned may be attracted to the United Kingdom. This policy, in our view, can best be carried out by the establishment of better harbours on the Empire trade routes, and, concurrently, by the existence of improved and cheaper shipping facilities. On both of these subjects we shall have more to say later on. Lastly it is, in our opinion, of much importance that the Dominions should prepare their produce in the manner most suited to the requirements of United Kingdom consumers, and equally that the United Kingdom should give all possible facilities for the handling and marketing

of Dominion produce. This latter subject is dealt with in detail in Chapter X of this report."

Dealing with the special action necessary in particular cases, the Commission reports:—

ZINC.

"There is little doubt that sufficient zinc or spelter for the needs of the Empire is contained in the zinc ore and concentrates which it produces. Australia alone has an output of zinc ores and concentrates averaging 500,000 tons per annum, and containing between 200,000 and 250,000 tons of metallic zinc, whilst there is an appreciable and growing production of ore in Canada. The difficulty lies, not in any deficiency of the output of ore within the Empire, but in the fact that the reduction processes have hitherto been carried on abroad. Practically all the Australian zinc concentrates were sent before the war to Belgium or Germany for treatment, and the Spelter Convention which controlled the output of spelter before the war was mainly under German influences. The whole of the zinc ore from British Columbia was smelted in the United States. The position was that the United Kingdom produced only a fraction of its consumption of spelter which amounts to about 200,000 tons per annum.

"We are glad to be able to say that this state of affairs is in course of remedy. Arrangements have been completed by Your Majesty's Government with the Zinc Producers Association of Australia for the purchase of 45,000 tons of virgin spelter and 100,000 tons of concentrates per annum for the period of ten years, with the right to purchase an additional 50,000 tons of concentrates a year. This, of course, involves arrangements for the erection of plant for reducing the concentrates both in Australia and the United Kingdom.

"Further, in Canada, a bounty for a limited period for the production of spelter has been provided by the Dominion Zinc Bounties Act of 1916, the object being to encourage the erection of electrolytic refining works. As a result of this assistance and the great activity and perseverance of the Consolidated Mining and Smelting Co. at Trail, British Columbia, already some fifteen tons per diem of practically pure zinc are being produced, with a certainty of considerable extension of output later on.

"It is difficult at the present time to say whether these measures are by themselves sufficient to prevent the risk of some part at least of the zinc ore, etc., produced in the Empire from passing outside its own control on its way from the Empire producers to the Empire consumers, and this is a matter which, in our opinion, should engage the serious attention of the Imperial Development Board to which we have referred. As an illustration of the danger to which we allude, we may mention that, before the conclusion of the arrangements with Australia which we have mentioned, it was publicly stated that the capacity for spelter production in the United States of America would

be, at the end of 1916, normally three times as large as the probable domestic demands, and that at the end of the war a large number of smelting works were likely to be suddenly extinguished unless arrangements could be concluded to smelt a very large portion of the Australian output in the United States.

TUNGSTEN ORE.

"Of essential raw materials, one of the most outstanding at the moment is tungsten in its various ores, in particular wolfram and scheelite.

"Before the war imports of the metal and its ores were not even separately recorded in the United Kingdom trade returns, but it is well known that the metal was obtained almost wholly from Germany, to which, as the trade statistics of the Dominions showed, almost all the ore was sent. It is said that by purchasing and treating the lower grade ores, which British firms would not buy, Germany gradually acquired control even of the best ore.

"In the course of the war, as we have already had occasion to observe, Your Majesty's Government found it necessary to buy up the whole production of the ores in Australia and New Zealand, as well as in other parts of the Empire, and to supervise the arrangements for their treatment in the United Kingdom before they could be used for the manufacture of steel.

"We think it most desirable that the principle of State purchase of tungsten ores should be maintained for a number of years after the war, and as at present practically the whole demand for the metal within the Empire lies in the United Kingdom, we suggest that arrangements to this end should be made direct by Your Majesty's Government in consultation with the Oversea Governments. The selling arrangements to the individual manufacturers could no doubt be carried out on the same lines as those at present existing. It may, of course, be necessary for Your Majesty's Government to take further measures to maintain in the United Kingdom the tungsten manufacturing industry.

MONAZITE.

"Prior to the war the control of deposits of monazite sand in various parts of the Empire and the manufacture therefrom of thorium nitrate, an essential requirement for the manufacture of incandescent mantles, were almost entirely in foreign hands. Since the outbreak of war the control of monazite deposits in Travancore, South India, has been transferred to the United Kingdom. The production of thorium nitrate in the United Kingdom has simultaneously been developed, and we regard the position as satisfactory so long as there is no possibility of the monazite deposits in India again passing under alien control."

Respecting articles mainly produced and controlled outside the Empire, the Commission lay down certain general principles on which, in its opinion, action should be based.

In the forefront they place co-ordinated investigation and research with the object of increasing available supplies, and the following are the lines on which they consider inquiry should take place:—

MINERALS.

"In the case of minerals, a properly co-ordinated mineral survey of the Empire appears to us to be an urgent necessity. We recognize the value of the work hitherto performed by the Imperial Institute in collecting and disseminating the results of mineral and geological surveys in various parts of the Empire and, in some cases, of actively directing them. We have also seen the joint recommendations recently made by the Iron and Steel Institute, the Institute of Metals, the Institute of Mining Engineers, and the Institute of Mining and Metallurgy, for the systematic collection and co-ordination of information bearing on the use of minerals and their production, and the investigation of all questions and problems relating to the utilization of the mineral or metallurgical resources of the Empire. Without endorsing their suggestion for the formation of a single Imperial Department of Minerals and Metals—a proposal which appears to us to offer constitutional and administrative difficulties at present—we are in sympathy with the general tenor of the proposals and consider it urgent that systematic work in the direction indicated should be undertaken by the proposed Imperial Development Board, working in conjunction and co-operation with the existing scientific and research departments and institutions of the various Governments of the Empire.

"In particular it appears to us of most pressing importance to ascertain whether workable deposits exist of such minerals as quicksilver, platinum, borax, and potash, which are at present obtained almost solely from foreign sources. Also, where quantities of such minerals, *e.g.*, platinum, are known to occur in conjunction with other ores, it is imperative that steps should be taken to secure their recovery.* Further, investigation is needed, both in the case of minerals of which Empire supplies are at present unknown and in the case of minerals already worked, in order to determine the most economic means of production. It is unnecessary for us to emphasize the waste of resources which has occurred, and is still occurring, in many countries through uneconomical methods of extraction. To take only one example—it has been estimated that at the Rio Tinto Mines in Spain in the period of some thirty years about seven million tons of sulphur valued at not less than £14,000,000 sterling were wasted through unskilful treatment of the ore, while, through modern improvements in the method of handling ore, about one million tons of sulphur are annually saved to the world which would otherwise have been burnt and served only to pollute the atmosphere.

* NOTE.—It has been stated that if the smelters of nickel, copper, and other ores could be induced, or required by legislation, to recover the platinum, palladium, etc., contained in them, the British Empire could probably produce its own supply of these metals.

"We recognize, of course, the work which has been done by various mining companies and unofficial institutions in the matter of investigating the best means of extracting ores, but we regard the whole subject as one which affects not only the capitalist and the shareholder but the Empire as a whole. We, therefore, think that investigations and experiments might be carried out under the direction of a central board working in the manner outlined above, which would also collate and disseminate the reports of private investigations.

"We do not ignore the equally important problem of avoiding waste in the consumption of the mineral and other natural wealth of the Empire; but this involves so many important questions of very wide bearing that we do not propose to do more than to refer to it.

PETROLEUM.

"The question of the petroleum supplies of the Empire is so important as to deserve special mention.

"The known supplies within the Empire compare unfavourably with those at the disposal of several foreign powers, and it is well known that, even before the war, successful efforts were made in Trinidad, New Zealand, and elsewhere to secure for Government purposes an option over the supplies produced from British sources.

"We would suggest, in view of the importance of petroleum as an asset to the Imperial and Dominion Navies, that where in any part of the Empire an extensive oil-bearing area is found, steps might be taken to reserve some portions from public competition, so that, where circumstances permit, special provisions may be made for their development and the employment of the product for naval purposes. This course, we understand, has been already adopted by the Governments of the United States and Russia, and the example would seem well worth copying in the British Empire.

"It would also seem desirable to make the principle of local refining of general application in the Empire, and, if possible, to insist on the erection of plant capable of refining to a specification approved by the Admiralty or Dominion naval authority.

FOREST PRODUCE.

"In a previous chapter of this report we have called attention to the immense size and value of the forest resources of the Dominions, but at the present time the actual production of timber within the Empire is insufficient for its consumption. The United Kingdom is largely dependent upon Scandinavia for supplies, not only of timber, but also of wood-pulp and pit-props. It appears to us of importance that some investigation should immediately be undertaken in order to ascertain what cut of timber can actually be made within the Empire without drawing on capital supplies, and that thorough and co-ordinated systems of timber conservation and forestry management should be agreed on between the technical officers of the Departments of Your

Majesty's Governments. At the present time Canada is estimated to have between two and three hundred million acres of commercial timber, but the output of lumber is only approximately that of Germany where timber is cut on an area of twenty-five million acres only. The German output comes from lands which have taken at least a hundred years to bring to their present perfection as timber producers. It is clear that investigation is needed into the best methods of conservation within the Empire and that careful observation should be maintained of the ratio between production and consumption. We recognize the value of the work which has been done in this direction in Canada, and consider that similar work should be carried out for the Empire as a whole.

AGRICULTURAL AND SIMILAR PRODUCE.

"In our third class we include articles of which the supplies can rapidly be increased by extending the area or intensity of production. In the main this class will be found to coincide with that of agricultural produce generally. The investigation in regard to this category of materials will naturally be directed towards ascertaining what part or parts of the Empire have the soil, climate, and other conditions most suited for their production. This work is eminently one for joint action; however, as an illustration of what might be done, we propose to consider the case of two commodities which we regard as of outstanding importance, namely, cotton and maize.

"*Cotton.*—The dependence of the Empire, and indeed of the world, on the United States of America for the bulk of its supplies of raw cotton is too well known to need detailed comment. The United States provide, approximately, 70 per cent. of the cotton crop of the world, and the dependence of the United Kingdom upon the supplies from this source is enhanced by the fact that the major portion of British spinning machinery is specially adapted to the spinning of cotton of the American type. Moreover there is already, generally speaking, a deficiency in the world's annual cotton crop, as compared with the world's demand, and it may be that, unless special steps are taken, this deficiency will tend to increase in the near future.

"The need for increasing the supplies of cotton within the Empire is therefore urgent.

"No doubt the more tropical parts of the Empire, such as India, Egypt, East and West Africa, and the West Indies, afford at first sight the most promising fields for development of the cotton industry, but, as we have had occasion to show in our Second and Third Interim Reports, there is a far greater opportunity in Australia and the Union of South Africa than is generally known.

"It is clearly desirable that immediately circumstances permit each of these Dominions should proceed further with the local investigations already promised or undertaken, and in particular we urge—

"(*a*) that expert advice should be sought by the Commonwealth and Queensland Governments;

"(*b*) that further inquiries should be made, if possible by the Commonwealth and Union Governments conjointly, into the possibilities of a mechanical picker;

"(*c*) that the British Cotton Growing Association should continue to afford to both Governments the measures of co-operation already agreed.

"*Maize.*—As in the case of cotton, the Empire is practically dependent on outside sources (mainly the Argentine) for its supplies of maize. Quite apart from its present importance for human food, for feeding to cattle, pigs, and poultry, and for the production of starch, maize is of great potential value as a cheap and easy source of industrial alcohol. The Union of South Africa and Rhodesia together form a most promising field for development, and apart from the measures taken to stimulate the growth of maize for food and for agricultural purposes, we suggest that the Government of the Union would do well to obtain expert advice as to the possibility of using its maize locally for the production of industrial alcohol, and if possible to undertake the construction of an experimental factory.

"It is quite conceivable that investigation and research in the direction indicated as regards each of the three classes mentioned may show that there are no adequate means of obtaining sufficient supplies of some commodities within the Empire In such an event, further investigation or research would be necessary to determine possible substitutes. As an illustration of what should be done in this directon we may mention the case of nitrates and potash.

NITRATES.

"The dependence of agriculture on nitrogenous manures and the importance of nitric acid for war purposes bring into relief the necessity for the control of adequate supplies of the raw materials on which these substances depend. In the past the huge Chilian deposits of nitrate of soda were almost the sole source of supply, but more recently this mineral has been replaced by synthetic nitrates, which have been produced on a large scale in Norway and elsewhere by fixing the nitrogen from the air. This industry has also largely developed in Germany since the outbreak of war.

"We regard it as of the greatest importance to stimulate within the Empire the production of adequate and suitable agricultural fertilizers, especially in view of the future needs of the vast grain-producing areas of Canada. Various technical questions arise in this connection, and these, we think, should be investigated with the necessary expert assistance, by the proposed new Imperial Board. We emphasize the fact that the water power of Canada and New Zealand should place these Dominions in a very favourable position for the production of synthetic nitrogen compounds. In this connection we would also refer to the need for investigating the possibilities of utilizing the immense deposits of peat which exist in Ireland, Canada, and other parts of the Empire as a source of fuel and agricultural fertilizers.

POTASH.

"The Empire, and indeed the whole world, has been dependent in the past on large mineral deposits in Germany for their supplies of potash, which is essential both as a fertilizer and in the production of numerous fine chemicals. Investigations, so far, do not point to the probability of the existence of any large workable deposits within the Empire, and the question of other means of obtaining potash appears to offer a more promising field for investigation than the search for natural supplies. Already the manufacture of potash from feldspar by a hydro-electrical process in Canada is contemplated. Attention is also being devoted in Canada and other parts of the Empire to the possibility of obtaining potash from vegetable sources, *e.g.*, kelp. Our attention was called by witnesses in Victoria and Vancouver to the existence on the coast of British Columbia of large available supplies of suitable seaweed. Sir William Macgregor, in an address before the Royal Society of Arts, mentioned the existence of huge accumulations of kelp off the coast of Labrador. Kelp burning is also practised on the west coast of Ireland, where there are considerable deposits. There is no doubt that similar accumulations exist in other parts of the Empire, but investigation is needed as to the possibility of utilizing them as a source of potash."

The report next deals with investments of capital in developing raw material resources, and states:—

"It is unnecessary to emphasize the influence which wise direction of the investment of British capital could exercise on the development of the natural resources of Your Majesty's Dominions. Here we need only deal with the question of similar investments in foreign countries. Special cases may arise in which raw materials of great economic and military importance, *e.g.*, quicksilver and platinum, cannot be found in sufficient payable quantities within the Empire. In this event we regard it of importance that British capital should be directed towards the multiplication of sources of supply.

"If supplies cannot be obtained from British sources it is clear that in the general interests of the Empire its civil and military industries should draw their supplies from as many sources as possible, and not depend on a single foreign country for their requirements."

As regards direct Government stimulus to production, the Commission states:—

"The lines of action which we have hitherto suggested in order to stimulate within the Empire the production of commodities for which it is at present dependent on foreign sources have mainly been those of scientific investigation and research co-ordinated under and arranged by an Imperial Development Board. We are conscious, however, that it may be many years before such investigation yields its full result, and we propose to refer here to certain more immediate and direct lines of action which it may be desirable to follow in the meantime. Many of

these, it will be seen, are already adopted by various States. Measures of this kind fall under the following principal heads:—

"(*a*) *Bounties on Output.*—The Government of the Commonwealth of Australia has for several years granted bounties in order to encourage the manufacture and production of various articles in the Commonwealth. These, in the main, are agricultural products. For some time past a bounty has been given on the output of cane and beet sugar in Australia, whilst cotton, flax, and hemp, as well as dried fruits, have also received a bonus. Canada has for some years been paying a bounty on lead and crude petroleum and, as we have already mentioned, has now provided a bounty on the output of zinc, whilst the Ontario Government has for some time paid a bounty on cobalt oxide.

"(*b*) *Government Purchase at a Minimum Price.*—This means of stimulating production can, in our opinion, be properly applied only to articles of which increased production is vitally necessary to the Governments of the Empire, either individually or as a whole, or of which it is essential, in the national interests, to control the whole output.

"(*c*) *Restriction of Foreign Control.*—We may mention here the 'British Character' Clauses contained in such legislation as the Canadian Crown Lands Regulations for the disposal of petroleum rights in Manitoba, Saskatchewan, Alberta, and other Dominion lands. These regulations contain the following provisions:—

> "(*a*) Any company acquiring a lease shall at all times be and remain a British company, the majority of the directors shall be British subjects, and the company shall not be directly or indirectly controlled by foreigners or a foreign corporation.
>
> "(*b*) The Dominion Government may at any time take over, subject to compensation, the whole of the locations acquired under the regulations, with all the works, machinery, and plant.

"The New Zealand Mining Amendment Act of 1914 contains similar provision as to the taking over of oil-bearing property and works in time of war.

"These clauses might be applied more widely and by other Governments of the Empire, not only to petroleum but also to other minerals if there is reason to apprehend that effective control might pass into foreign hands. In particular we should be glad to see them applied to the oil-bearing shales of New Brunswick and to Government leases of Crown lands to any company intending to produce wood-pulp or paper.

"(*d*) *Restriction of Government Purchases to Articles produced from Empire Materials.*—It is not perhaps generally realized to what extent, even in times of peace, Government departments are purchasers of various classes of goods; thus, the Union of South Africa imports normally about £3,000,000 worth of railway materials and other merchandise on Government account, whilst similar imports into India are even larger. In calling for tenders for the supply of merchandise and the execution of contracts, many Government departments already accord

preferential terms to British articles, and we consider that as a means of stimulating the output of essential materials within the Empire, this practice might be extended, especially in regard to such articles as might be scheduled by the suggested Imperial Board as requiring special treatment.

"In our view it should be left to the various Governments of the Empire to continue or extend such measures as we have described under these four heads until the details of the numerous problems involved have been carefully worked out, with competent scientific advice, by the suggested Imperial Development Board.

"The advice of such a Board will enable the different Governments to take such measures as are necessary with a wider outlook and fuller appreciation of the requirements of the Empire as a whole."

SUMMARY.

The main conclusions and recommendations under the heading of natural resources are summed up as follows:—

"(*a*) We regard it as vital that the Empire's supplies of raw materials and commodities essential to its safety and well-being should be, as far as possible, independent of outside control. As the first step towards ascertaining how such independence can be secured, we recommend that an immediate survey should be undertaken of the relation between Empire production and Empire requirements of these materials and commodities, such survey to be made by an Imperial Development Board. This body should further be entrusted with the duty of watching and reporting on the changing requirements of the Empire in respect of raw materials.

"(*b*) Working on the results of the survey when completed, the Imperial Development Board should next address itself to the question whether the Empire can produce those raw materials and commodities which now are, or may in the future be found to be, produced and controlled outside its limits.

"(*c*) The Board should have funds sufficient either itself to investigate, or to promote the investigation of:—

"1. Measures to prevent waste in existing sources of supply.

"2. The possibilities of new sources of supply.

"3. The possibilities of substitutes where supplies of any commodity of importance are found not to be available within the Empire.

"(*d*) Your Majesty's Government and the Oversea Governments should in the meantime take steps to stimulate output and control supplies on the lines indicated above.

"Other functions for the proposed Imperial Board are dealt with elsewhere."

(To be continued.)

Report on Certain Minerals Used in the Arts and Industries.

I.—ASBESTOS.

By Percy A. Wagner,* Dr. Ing., B.Sc., F.R.S.S.A., M.A.I.M.E., Consulting Economic Geologist.

CONTENTS.

1.—Composition and Classification.
Types of Fibre.
2.—Valuation and Physical Properties.
3.—Commercial Uses.
4.—Sources of Supply:
Canada.
Asbestos Dressing in Canada.
Russia.
The United States.
Cyprus.
South Africa.
Occurrences of Chrysotile Asbestos.
Southern Rhodesia.
Transvaal.
Carolina District.
Krugersdorp District.
Zululand.
Protectorate of South-West Africa.
Occurrences of Tremolite-Asbestos.
Zululand.
Occurrences of Crocidolite Asbestos.
Griqualand West.
Occurrences of Iron-Amphibole Asbestos.
Transvaal.
Lydenburg District.
5.—Position and Prospects of the South African Asbestos Manufacturing Industry.

1.—COMPOSITION AND CLASSIFICATION.

The term asbestos, from the Greek ἄσβεστος meaning inextinguishable, is applied rather loosely to a number of distinct minerals having in common a peculiar fibrous structure that admits of their being shredded and other special qualities by virtue of which they have found extensive application in the industrial arts.

* The writer is indebted for valuable assistance in the preparation of the report herewith presented to Messrs. Tudor G. Trevor, S. Weingarten, T. H. B. Wayne, A. L. Hall, Francis Oats, F. Hirschhorn, T. Reunert, W. Greenacre, Wm. Palmer, Malcolm Barker, Drs. A. W. Rogers and G. S. Corstorphine, Prof. G. H. Stanley, and the Acting Secretary for Mines, Southern Rhodesia.

The following is a list of the minerals that, under certain conditions, crystallize in the form of asbestos:—

(1) Serpentine, chemically hydrous magnesium silicate, represented by the formula $H_4Mg_3Si_2O_9$, of which there are two principal fibrous forms, namely, chrysotile and picrolite.

(2) Anthophyllite, chemically magnesium-iron silicate, represented by the formula $(Mg,Fe)SiO_3$.

(3) Tremolite, chemically calcium-magnesium-silicate, represented by the formula $CaMg_3Si_4O_{12}$.

(4) Actinolite, chemically calcium-magnesium-iron silicate, represented by the formula $Ca(Mg,Fe)_3(SiO_3)_4$.

(5) Crocidolite, a sodium-iron-silicate, represented by the formula $NaFe(SiO_3)_2FeSiO_3$.

(6) Iron-amphibole, as found in the Lydenburg District of the Transvaal, a complex silicate rich in iron, and which, to judge by such analyses as have been made, contains variable quantities of calcium, magnesium, and aluminium.

The five last-mentioned minerals belong to the amphibole group.

Of the foregoing, chrysotile asbestos or asbestiform chrysotile, as it is also called, is by far the most important, about 90 per cent. of the asbestos used at the present time being of this variety.

Iron-amphibole and crocidolite-asbestos, of the production of which South Africa has virtually* a monopoly, rank respectively second and third in importance, and in view of the great extent of the South African deposits of these minerals they are undoubtedly destined to play a very important rôle in the asbestos manufacturing industry. There is no probability, however, of either of them ever rivalling chrysotile asbestos, for, quite apart from the fact that the available supplies of that mineral are practically unlimited, there are a number of uses to which it is specially suited and for which the other varieties of asbestos do not form satisfactory substitutes.

Types of Fibre.—Asbestos is classified according to its mode of occurrence into cross-fibre, slip-fibre, and mass-fibre.†

Cross-fibre occurs in veins in which the fibres are perpendicular or approximately perpendicular to the enclosing walls.

Slip-fibre is found along fault-planes, the direction of the fibres corresponding with the direction of displacement.

Mass-fibre occurs in the form of rock masses made up entirely of groups and bundles of more or less radial asbestos fibres.

Most of the commercially important deposits of asbestos are of the cross-fibre variety.

2.—VALUATION AND PHYSICAL PROPERTIES.

The industrial importance of the different varieties of asbestos is dependent on the fact that they are capable of being split up into thin flexible fibres which, in addition to being more or less fire and acid proof, can be spun into yarn and woven into cloth, and, when worked

* Western Australia produces small quantities of crocidolite asbestos.

† *Cf.* Taber, Stephen, "Trans. Am. Inst. M.E.," 1916, p. 1976.

up and carded, rank among the best non-conductors of heat.* This applies, of course, to good fibre which may readily be distinguished, whatever its composition, by the fact that it is soft to the touch and can be bent and twisted without breaking. Flexibility and tensile strength are tested by separating a thin bundle of fibres and drawing these slowly over one's thumb-nail in such a manner as to bend them rather sharply, the while exerting a steady pull. Good fibre, which is tough and strong, beyond being split up into still finer fibres, remains unaffected by this treatment, while inferior fibre snaps. Another rough method of examining the quality of asbestos and its adaptability to textile purposes is to rub it between the palms of the hands. Good fibre works into a soft fluff, while inferior fibre breaks up and remains harsh to the touch. The commercial value of asbestos fibre is determined by its length, fineness, flexibility, tensile strength, heat and acid resisting properties, non-conductibility with respect to heat, freedom from foreign matter, and, last but not least, by its mineralogical composition. Thus, other things being equal, chrysotile asbestos always commands a higher price than the other varieties owing to its exceptional spinning qualities. The best grades of chrysotile asbestos realize up to £75 per ton, and the best grades of crocidolite asbestos up to £65 per ton.

As regards the physical properties of the different asbestiform minerals, anthophyllite, tremolite, actinolite, and chrysotile are all capable of withstanding exposure to very high temperatures, but whereas anthophyllite, tremolite, and actinolite asbestos are, generally speaking, not sufficiently flexible to be well adapted to spinning and weaving and are of deficient strength, chrysotile asbestos, as already stated, is by reason of its silkiness and flexibility eminently suited to textile purposes.

Asbestiform crocidolite, owing presumably to its high sodium content, is easily fusible in an ordinary gas flame, swelling to a black magnetic glass and colouring the flame yellow. On the other hand it possesses greater tensile strength, and is more elastic than chrysotile, and its superiority over that mineral as an insulating material with regard to heat is well established. Similar superiority is also claimed for electrical insulating purposes. Its chief advantage over chrysotile asbestos lies, however, in the fact that it offers far greater resistance to the action of acids, chemical solutions, and sea-water. Sea-water and moist sea-air slowly decompose ordinary chrysotile asbestos, whereas the crocidolite variety is practically unaffected by them. This fact was first demonstrated in Germany and led to the use of the mineral in place of chrysotile asbestos being made compulsory in the German Navy for covering boilers, steam-pipes, etc. Of recent years it has also been extensively employed in the British, French, and Italian navies and mercantile marines.

In regard to the physical properties of the iron-amphibole asbestos of the Lydenburg District very little is known. Judging by its chemical composition it should be markedly superior to crocidolite in fire-resisting power and to chrysotile asbestos in its resistance to acids and sea-water. Its tensile strength appears to be of a high order.

* Crude asbestos itself does not rank among the highest of non-conducting materials, but if carefully worked up and felted or woven so that air is included between the fibres its thermal resistivity is enormously increased. *Vide* "Bulletin of the Imperial Institute," London, 1905, p. 284.

3.—COMMERCIAL USES.

The manufacture of articles composed wholly or in part of asbestos forms at the present time a very important industry and one that is rapidly expanding, since new uses for one or the other of the different varieties are constantly being discovered.

The longer and finer grades of fibre can be employed for most of the purposes to which ordinary vegetable fibre is put, chrysotile asbestos, in particular, being extensively used in the manufacture of asbestos cloth for fire-proof drop-curtains, asbestos garments, gloves, helmets, and masks, asbestos rope, yarn, belting, and twine. It is also ideally suited for piston-rod packing owing to the fact that it is slightly softer and more unctuous than the other varieties. The finest grades of chrysotile are used for giving weight to silk.

Other important articles in the manufacture of which the remaining varieties of asbestos are also employed are asbestos filter-cloth, asbestos rubber-cloth, asbestos felt and roofing felt, asbestos-asphalt, and asbestos-gum compositions for electrical insulation, asbestos paper and corrugated paper, fire-proof asbestos paints, asbestos mill-board, which is used in the stove industry, for stove mats, for lining fire-proof safes, in electric furnaces, for stage scenery, joint packing, and in the insulation against fire of picture palaces.

Considerable quantities of asbestos are used for making mattresses and insulating compositions and cements for covering boilers and steam-pipes, the crocidolite variety being specially suited to these purposes. In the insulating compositions and cements the asbestos is generally mixed with magnesia or calcined kieselguhr and a suitable binder.

One of the most recent uses to which asbestos has been put is for lining the band-brakes of motor cars, considerable quantities being employed for this purpose.

Another recent application of great importance is in the manufacture of asbestos-covered metal. This consists of steel sheeting hermetically sealed in an adhesive asphaltic compound, which is covered with a thin layer of asbestos felt. It will resist fire, rust, and corrosive liquids and fumes. Roofing and siding sheets of asbestos-covered metal are widely used in the United States in factories and mine buildings.

Short asbestos fibre is employed in fairly large quantities in the preparation of asbestos plaster and stucco, which are claimed to be practically sound-proof.

The bulk, however, of the medium and shorter grades of asbestos fibre produced at the present time is used in combination with cement in the manufacture of fire-proof building material. The employment of asbestos for this purpose dates from 1906, when asbestos-cement slates, tiles, and sheathing were first made. From that date the demand for these and allied articles—asbestos boarding, bricks, lumber, wood, etc.—has increased at such a rate that factories for their production have been established the world over. Asbestos slates and tiles, in addition to being very durable and moisture, fire, and vermin proof, tend to maintain the interiors of buildings on which they are used at a practically uniform temperature all the year round. Since the outbreak of the war asbestos has been employed largely in naval construction, and an indication of the importance

that is attached to it for this purpose may be had from the fact that the British Government shortly after the outbreak of hostilities placed an embargo on all classes of crude asbestos.

4.—SOURCES OF SUPPLY.

The principal asbestos-producing countries in order of their pre-war importance are Canada, Russia, South Africa, the United States, and Cyprus.

CANADA.

The chrysotile-asbestos mines, or more correctly speaking quarries, in the Province of Quebec, Canada, are responsible for about 75 per cent. by weight of the world's annual production of asbestos. The Canadian output amounted in 1915 to 113,118 tons, valued at £727,310. It is very important, however, to note that of the total production only 4 per cent. was fibre over $\frac{3}{4}$ in. in length, and only 1.4 per cent. fibre over 1 in. in length. The balance of the output, namely, 96 per cent., consisted of short and medium length fibre worth on an average from £1. 10s. to £11 per ton.

The asbestos occurs in narrow veins traversing masses of ancient serpentine, the deposits being of enormous extent. The mining of the asbestos-bearing serpentine is for the most part carried out in open quarries, some of which have attained a depth of over 200 feet.

Up to the year 1890 the Canadian asbestos industry was in much the same condition as that of South Africa is at the present day. Hand-cobbing was practically the only method of dressing resorted to and no attempt was made to save the shorter grades of fibre.*

The Canadian deposits, as previously indicated, produce only a very small proportion of long fibre, and as the cost of labour on the fields has always been comparatively high, it became apparent about this time, owing largely to a slump in the asbestos market, that unless adequate methods for the recovery of the shorter classes of fibre were introduced only the richest mines would be able to carry on operations at a profit. Experimental dressing plants were in consequence erected and proved so successful that mechanical treatment began in ever increasing measure to replace hand-cobbing, and at the present day every quarry is equipped with elaborate machinery for the saving of the smaller fibre, which in the earlier years was left in the rock and thrown on the dumps. Numerous uses have been found for this material, and the flourishing condition of the Canadian asbestos industry is due largely to its successful recovery.

As there is great scope on the South African asbestos fields for the saving of the shorter grades of fibre and the more general employment of mechanical treatment devices, a brief account of the dressing methods in vogue in Canada may prove of interest and utility.

Asbestos Dressing in Canada.†

Hand-dressing.—At certain mines—for instance, those in the Broughton District—which yield a very limited quantity of long fibre,

* *Cf.* Cirkel, F., "Chrysotile-asbestos, its Occurrence, Exploitation, Milling, and Uses," second edition. Mines Department, Ottawa, 1910.

† *Cf.* Cirkel, *loc. cit.*; Stokes, Ralph, "The Mines and Minerals of the British Empire," pp. 324–334; "Bulletin of the Imperial Institute," London, 1908, pp. 393–399; Penhale, J. J., "Trans. Can. Min. Inst.," 1913, March 5; "The Mineral Industry," 1894–1915.

hand-cobbing has been completely superseded by mechanical treatment. Usually, however, the bulk of the longer fibre is recovered by the former process. As a preliminary to the cobbing the material broken by blasting in the quarries is separated by hand-sorting into—

(1) long asbestos fibre (everything over $\frac{1}{2}$ in.) freed by the blasting operations and pieces of rock containing it, which are sent to the cobbing sheds;
(2) milling material, that is, rock containing the shorter fibre, which is sent to the mill;
(3) dead or waste rock which goes to the dumps.

Fine material and scrapings of the pits resulting from the blasting and breaking up of the rock by means of sledge hammers are also sent to the mill.

In the cobbing sheds the longer fibre is separated by cobbing with one-handed sledge hammers and sieving from the encasing rock and the shorter fibre.

Some mines make only "No. 1 crude" measuring over $\frac{3}{4}$ in. in length, while in others a "No. 2 grade," which includes all fibre from $\frac{5}{16}$ in. to $\frac{3}{4}$ in., is also made.

The "crude" or hand-cobbed fibre, as already indicated, represents about 4 per cent. by weight and from 25 to 30 per cent. by value of the total production.

Mechanical Treatment.—The mechanical dressing of the asbestos-bearing serpentine, which has for its object the complete liberation of the fibre and its separation from the adhering rock particles and dust, involves—

(*a*) preliminary crushing preferably in two or more stages by jaw or gyratory breakers often supplemented by rolls;
(*b*) the drying of the crushed rock since the inclusion of wet material in the feed greatly reduces the efficiency of the separating machines in addition to tending to discolour the fibre. The drying is carried out in rotary driers or on steam-heated drying floors;
(*c*) the pulverization of the serpentine in such a manner as to liberate the delicate fibres without unduly breaking or damaging them. The appliance most generally employed for this purpose is the so-called "cyclone" pulverizer, which has for its most important parts two beaters of chilled cast-iron shaped like three-bladed propellors. These are driven at from 1800 to 2200 revolutions per minute in opposite directions, breaking the pieces of rock by their impact and throwing the fragments against one another with terrific force. Ordinary crushing rolls are also employed and have been installed in place of cyclones in some of the more recent mills. It is contended, however, that the rolls tend to crush the rock particles into the fibre, thus reducing its value;
(*d*) the separation of the fibre from the crushed rock. This is effected by screens from which the fiberized asbestos is taken up by means of suction fans and carried in suspension into suitable collectors or settling chambers;
(*e*) classification of the settled fibre by means of grading screens, revolving or shaking. It is generally separated into three grades known as mill stock No. 1, mill stock No. 2, and

mill stock No. 3. The last named, which consists of the shortest fibre, is also sometimes termed "paper stock" from its use with vegetable fibre in the manufacture of paper.

The tailing of the grading-screens, consisting of a mixture of very short fibre and crushed serpentine, is by further crushing, generally in large emery mills, converted into *asbestic*, a fine asbestos-serpentine powder, which is largely employed in the construction and inside finish of fire-proof buildings and also in the manufacture of cement.

The design of the mills differs considerably, no two being exactly alike. The first cost of plants of the same capacity in consequence also varies within wide limits. Cirkel estimates the cost of equipping and erecting (in Canada) a mill capable of treating 480 tons of rock per diem at 52,885 dollars. The cost in South Africa at pre-war prices would be at least twice as great.

Working costs also vary considerably. In the Broughton District, where almost all the rock from the quarries passes through the mills and no "crude" is produced, the cost of production per ton of fibre ranged in 1910 from 12.5 dollars to 14 dollars per ton. In the Thetford and Black Lake quarries, where the production of crude enters into the mine costs, the average cost of extraction—crude and mill fibre combined—in 1910 was from 20 dollars to 27 dollars per ton, exclusive of head office expenses, amortisation, and insurance. Of recent years there is said to have been a considerable reduction in working costs.

The industry gives employment to about 3000 men and women, the annual wage bill being about 1,700,000 dollars.*

The Canadian Output in Detail.—The Canadian output for the year 1915 was made up as follows:—

	Tons.	Value per Ton. £	s.	d.
Crude No. 1	2,305.6	57	2	0
Crude No. 2	1,681.6	25	9	0
Mill stock No. 1	21,710	10	18	0
Mill stock No. 2	41,973	4	3	0
Mill stock No. 3	38,888	1	11	0
TOTAL	106,558.2	—		
Asbestic	25,700	0	3	6

The "crude" fibre is employed mainly in the manufacture of asbestos cloth, rope, yarn, and piston-rod packing; the No. 1 and No. 2 mill stock for making asbestos mill-board, felt, slates, shingles, and sheathing, etc., and the No. 3 mill stock as already indicated, for manufacturing paper, asbestos, paints, plaster, and insulating compositions for covering steam-pipes and boilers.

RUSSIA.

The asbestos mines of Russia are situated in the serpentine areas of the eastern slopes of the Ural Mountains. The asbestos is of the

* According to the Report of the Dominions Royal Commission.

chrysotile variety and the deposits of great extent. The production amounted in 1913 to 18,594 tons. Of this total between 5000 and 6000 tons represented crude or high-grade fibre, and the Russian output of "crude" therefore actually exceeded that of Canada, which in 1913 amounted to slightly over 4000 tons. The fibre, however, is, generally speaking, more brittle than the Canadian and Rhodesian. It is, as a rule, used together with Canadian asbestos in the manufacture of asbestos cloth, etc.* The Russian short fibre asbestos is especially suitable for making roof shingles, which in some parts of Russia have replaced ordinary roofing slates and tiles to a large extent.

In regard to the present condition of the Russian industry very little information is available, but there is said to have been a considerable drop in the output.

United States.

In the United States asbestos is found in Vermont, Virginia, Georgia, Wyoming, Idaho, Arizona, and California. The deposits of Georgia and Idaho are of the amphibole variety, and those of the other States of the chrysotile variety.† The deposits of Arizona, which are situated in the Grand Canyon, near the town of that name, are of precisely the same nature as those in the Carolina District of the Transvaal, the asbestos occurring in serpentinized dolomite above intrusive sheets of diabase.

The asbestos production of the United States amounted in 1915 to 1731 tons.

Cyprus.

The asbestos deposits of Cyprus are of considerable magnitude, but at present they are not worked to any great extent. The asbestos (chrysotile) is of fairly good quality and is used to some extent as a "sweetener" for the medium grades of Canadian fibre.

South Africa.

South Africa has vast resources of asbestos and produces a greater variety of commercial fibre than any other country. The asbestos industry, established in 1893, has of recent years made astonishing progress, as may be judged by the fact that whereas the 1913 output was worth only about £30,000, that for 1916 was valued at £182,129, and that for the first eight months of 1917 at £203,179. Production during the past two or three months has been at the rate of about 20,000 tons per annum, and the sub-continent at the present time almost certainly ranks as second among the asbestos-producing countries of the world in point of output, and first in point of crude fibre production. The industry appears, moreover, to be capable of almost indefinite expansion, and if the demand for the better grades of asbestos fibre continues to grow at the same rate as it has of late years South Africa may eventually challenge the supremacy of Canada in the value at any rate of her asbestos production.

---

* *Cf.* "The Mineral Industry," 1912, p. 56.
† *Cf.* "The Mineral Industry," 1915, p. 42.

For purposes of description it will be convenient to distinguish between occurrences of—

(1) chrysotile asbestos;
(2) tremolite asbestos;
(3) crocidolite asbestos:
(4) iron-amphibole asbestos.

Occurrences of Chrysolite Asbestos.

The most important South African deposits under this heading are those of Southern Rhodesia,* which at the present time are producing over 900 tons per month of chrysotile asbestos of excellent quality, the Rhodesian fibre being the only class of chrysotile asbestos that has been able to compete successfully with the best grades of Canadian "crude."

The mineral was first discovered in the Mashaba Mountains, about 26 miles west of Victoria, and the Victoria District until quite recently ranked as the premier producer. Within the last two years, however, extensive and very rich deposits have been opened up in the Belingwe District, and the output of these is at the present time slightly in excess of that of the Victoria District mines. Asbestos is also being worked in the Gwelo District, and finds have recently been reported from the Lomagundi District. The deposits are all in belts of ancient serpentine, and as these are very extensive and as yet but little known it is practically certain that many important occurrences still await discovery.

The asbestos is of the cross-fibre variety, and occurs under precisely the same conditions as the Canadian—in irregular narrow veins ramifying in every direction through the enclosing serpentine, the thickness of the veins varying from a small fraction of an inch to two inches, and exceptionally three and even four inches. The only exception to the ordinary mode of occurrence appears to be furnished by the Regina Mine in the Victoria District, where the asbestos occurs along a well-defined steeply dipping zone of fissuring which has been followed to a fairly considerable depth, and at the lowest level reached is just as strong and well marked as at the surface.

The fibre ranges in colour from pale green to pale greenish-white, that of the Belingwe District being somewhat longer and also more silky than that of the Victoria District. The quality, however, is excellent throughout, as may be judged by the fact that the most important firm of textile manufacturers in England have now for several years been employing Rhodesian asbestos to the exclusion of Canadian.

The fibre is readily separated from the matrix by cobbing and crushing and screening, most of the larger mines being equipped with mills. As in the Union, however, no attempt is made to save the shorter grades of fibre.

The asbestos districts are healthy, well watered and wooded, and native labour is cheap and plentiful, so that all the essentials for cheap mining are present.

* A report on the asbestos deposits of Southern Rhodesia is in course of preparation by H. B. Maufe, Director of the Geological Survey of Southern Rhodesia.

The following is a list of the Rhodesian asbestos mines, together with their outputs in 1916:—

District.	Name of Producer.	Amount.	Value.
		Tons.	£
Belingwe (Bulawayo Mining District)	Ad Valorem (Fromburg & Johnstone) ...	42	818
	Birthday A (N. Moore)	677	10,839
	Birthday C (Mrs. U. Longhurst)	27	432
	Mashaba (Taylor & Goddard)	19	295
	Nil Desperandum (E. H. Machell) ...	148	2,364
	Shabanie (Charterland and General Exploration and Finance Co., Ltd.)	94	1,503
	Tanga (H. Rosenthal)	5	186
	Wedza (J. Longhurst)	58	955
Gwelo	Beckjoy (J. S. Joel)	55	832
	Look Out (B. Koury)	3	45
	Mopani (Aronson & Readman)	69	1,104
	Waterbuck (Vermaak & Hartley)	40	599
Victoria	Balmain (P. T. Hoad)	254	3,996
	Clansman (A. Aronson)	8	128
	Gath's Asbestos [Victoria (R.) Asbestos, Ltd.]	1,683	26,816
	Hannah (Hendry & Martin)	129	1,345
	King [King Asbestos (R.), Ltd.]	2,593	42,760
	Regina (P. A. Nightingale)...	249	3,978
	Rosey Cross (Mrs. J. C. C. Goddard) ...	4	64
	Total production in year ended 31st December, 1916	6,157	£99,059

The asbestos production during August, 1917, was as under:—

District.	Tons.	Value.
		£ s. d.
BULAWAYO MINING DISTRICT—		
Ad Valorem (Fromburg & Johnstone)...	17·25	345 0 0
Birthday A (Willoughby's Cons. Co., Ltd.)	60·80	972 16 0
Birthday B (Willoughby's Cons. Co., Ltd.)	20·00	320 0 0
Nil Desperandum (E. A. Machell)	36·22	724 10 0
Shabanie A (Charterland G. E. & F. Co.)	308·00	4,928 2 1
VICTORIA DISTRICT—		
Balmain (P. T. Hoad)	16·00	240 0 0
Gath's [Victoria (R.) Asbestos, Ltd.]	200·66	3,210 13 1
King Asbestos (R.), Ltd.	174·15	3,683 5 5
King Asbestos (R.), Ltd.	87·85	812 12 3
	920·93	£15,236 18 10

A scheme for the amalgamation of a number of the mines was recently brought to fruition. The new company, which has a capital of £400,000, has acquired the properties of the Charterland and General Exploration and Finance Company and the Victoria (Rhodesia) Asbestos Company, as well as those of a number of smaller concerns.

The total production of asbestos in Rhodesia to the end of August, 1917, was 16,922 tons, valued at £302,334.

The available resources of fibre in the occurrences at present worked are enormous, and as there is every likelihood of further

deposits being discovered, and the product is of unrivalled quality, the asbestos industry of Rhodesia has without doubt a very bright future before it.

Transvaal: *Carolina District.*—Of a totally different character are the occurrences of chrysotile asbestos in the Carolina District of the Transvaal. They are situated about fifteen miles east of Carolina on the farms Diepgezet No. 33, Goedverwacht No. 32, and Rietfontein No. 70, in a tract of rugged mountainous country belonging topographically to the Drakensberg.

The asbestos occurs* in a bed of serpentinised dolomite in the uppermost division of the Dolomite formation immediately above a persistent intrusive sheet of diabase with which the deposits are believed to be genetically connected.

The asbestos-bearing dolomite, a massively bedded rock of delicate pale greenish-white colour, is said to be traceable at the surface for a distance of twenty miles, but only carries workable deposits of fibre over part of this distance. The asbestos is found in thin seams in the lower portion of the stratum, the seams running parallel with the bedding planes of the dolomite, which dips to the north-east at an angle of 15 degrees. They sometimes occur singly, but usually one finds two or three seams running parallel to one another and separated by a variable thickness of the country rock. The individual seams range in thickness from a fraction of an inch to 8 inches, thinning and thickening with the utmost irregularity. They are rarely continuous over any considerable distance and frequently die out within a few feet. The seams, as a rule, consist wholly of closely compacted parallel fibres extending from wall to wall without break or fault, the fibres being arranged at right angles to the bedding planes. In some instances, however, the fibres are inclined to the bedding. The "lying down" process, as it has been termed, can be seen in various stages and is attributed† to minor movements of adjustment in the dolomite subsequent to the formation of the asbestos deposits. Seams of "stony" chrysotile, in which the fibres of that mineral are intergrown with rock matter, are also occasionally met with.

The normal fibre is of excellent quality as regards length, flexibility, and tensile strength, and commands very high prices, the best grades realizing as much as £70 per ton.

The asbestos zone has been opened up by means of adits and tunnels, which on Diepgezet extend 400 feet into the hillside. The seams become progressively thinner as they are followed inward and appear eventually to pinch out altogether, inasmuch as no asbestos is found at the head of any of the deep valleys running into the hills.‡

The Diepgezet deposits were worked from 1906 to 1909 and again in 1913 and 1914. Since the beginning of the war all operations have been suspended owing to the internment of a number of those prominently connected with the property. The average thickness of the asbestos worked on the property in 1909 was only .92 inches.

The Goedverwacht deposits are being exploited by the Andes Company, which some time ago took over all the assets of the Anglo-French Asbestos Company. The asbestos is broken by longwall

* *Cf.* Hall, A. L., "Rept. Geol. Survey, Union of S.A." 1913, pp. 57–60.
† *Cf.* Hall, *loc. cit.*
‡ According to Mr. T. G. Trevor.

stoping and separated from the enclosing dolomite by cobbing and sieving, after which it is carefully graded. Fibre over an inch in length constitutes about 60 per cent. of the total output, and "fluff," separated from the finer rock particles by sieving, about 15 per cent.

About 10 tons graded fibre are produced per month, the average value of the fibre being £50 per ton.

Everything under $\frac{1}{2}$ inch is discarded, and there is in consequence a very considerable accumulation at the mine of dolomite containing recoverable fibre.

The deposits on this and the adjoining farms are very favourably situated for cheap mining and are easily accessible by a fairly good if somewhat circuitous road, the distance by road from Carolina being about twenty-two miles. In the opinion of those best competent to judge, however, the quantity of workable fibre available is limited owing to the tendency of the veins to become thinner when followed into the hills, and it is anticipated that the mines will be worked out within a comparatively brief period.

Barberton District.—An occurrence of chrysotile asbestos is being opened up on the farm Dalton, close to Kaapmuiden, in the Barberton District. Whether it is workable or not is not as yet known.

Krugersdorp District.—Chrysotile asbestos of good quality was reported some months ago* to have been discovered in serpentine, associated with the old granite, to the north of Krugersdorp. No precise information regarding the nature and extent of the deposits is available.

Zululand.—A deposit of chrysotile asbestos on which a good deal of work has at different times been done is situated at Isitilo in Zululand near Middle Drift on the Tugela River. At the present time the mine is closed down. In 1913 it produced 23.271 tons of fibre valued at £429, and in 1914 95.408 tons valued at £1697. The asbestos was of inferior quality and used mainly for making asbestos cement-slate and for covering steam-pipes.

Chrysotile asbestos in veins up to $\frac{3}{4}$ in. in width is also found near Eshowe, in Zululand, but the occurrence does not appear to be worthy of exploitation.

Protectorate of South-West Africa.—The writer has seen specimens of chrysotile asbestos of good quality from the hinterland of Swakopmund, but has not succeeded in obtaining any definite information regarding the occurrence.

Occurrences of Tremolite-Asbestos.—Zululand.

The Buffalo Asbestos Company are working a deposit of tremolite-asbestos near Pomeroy on the Maceheko River in Zululand. The fibre is soft and silky to the touch but of very low tensile strength, and is employed principally for covering boilers and steam-pipes. It appears to be admirably adapted for making asbestos millboard and for use as a filtering medium for acids and corrosive liquids.

There is said to be another occurrence of tremolite-asbestos in the neighbourhood of Pomeroy, but no information with regard to it is available.

* *Cf. S.A. Mining Journal*, 1917, p. 218.

*Occurrences of Crocidolite-Asbestos.—Griqualand West.**

Asbestiform crocidolite of a peculiar lavender blue colour, commonly known as blue asbestos, has been mined in Griqualand West for well over twenty years.

The mineral has a very wide distribution in the lower portion of the Pretoria series as developed in the Asbestos Mountains and their northern continuation, the Kuruman-Honingvlei range, the deposits extending from a point thirty miles south of the Orange River to the Bechuanaland border, a distance of fully 250 miles. The width of the asbestos belt ranges from four to twenty miles, and, as regards actual areal extent, it undoubtedly constitutes the greatest asbestos-bearing area in the world, the available reserves being for all practical purposes inexhaustible.

The asbestos occurs in thin layers and attenuated lenses conformably interbedded with the hard banded jaspers and ironstones of the Pretoria series. The fibre, as a rule, is arranged at right angles or inclined at a high angle to the bedding planes. It varies in length from a maximum of about 3 inches to almost microscopic dimensions.

Over a great part of the asbestos country the strata are practically horizontal and the same bed will often appear on successive hills. At Koegas, on the Orange River, however, and also at Westerburg, the beds have been folded, the dip being almost vertical. In other localities the strata are contorted owing, it is presumed, to the removal through solution of the underlying dolomite. Where this is the case the asbestos layers are sometimes seen to thicken in the arches and troughs, and to disappear altogether in the connecting limbs.

On some properties single seams of asbestos, averaging not more than 1 inch in thickness, are being profitably worked. On others, as for example at Koegas and Westerburg, four or five and, in some cases, nine or ten seams, ranging from $\frac{1}{4}$ in. upwards, occur within a zone of from 12 inches to 24 inches. Such a concentration of asbestos, however, is exceptional, and, as a rule, quite local. Thus, Frood mentions exposures in which as many as from twelve to seventeen seams are to be seen on a face of not over 6 feet, whilst 20 feet away the number of seams is reduced to two or three.

Owing to the irregular distribution of the asbestos, both as regards the number of seams found from point to point and the persistence of the individual seams, actual development alone can determine how any particular seam or group of seams is likely to behave.

The fibre from different parts of the asbestos area varies somewhat in character. That of the Kuruman District has a slightly lower specific gravity than that of Koegas and the southern districts, and is also softer and more silky when carded. These differences correspond no doubt with slight differences in chemical composition.

In regard to the average length of the fibre produced on the Griqualand West fields, no data are available, but the proportion of an inch and over in length is variously estimated at from 10 per cent. to over 25 per cent.

* *Cf.* Rogers, A. W., "Repts. Geol. Comm. Cape of Good Hope," 1899, p. 59; 1902, p. 28; 1903, p. 187; 1905, pp. 158–161 and p. 169; 1907, pp. 147 and 177; 1908, p. 22; and Frood, G. E. B., "Memorandum on the Asbestos Industry in the Cape Province." Report of the Government Mining Engineer, Union of South Africa, 1915, pp. 76–82.

In the Kuruman District rusty and discoloured fibre are greatly in evidence. The former results from the oxidation of blue asbestos and is practically valueless. The latter, apart from being off-colour, does not appear to differ markedly in physical properties from the normal fibre. Originally there was a great deal of prejudice against it, but this seems to be disappearing. Thus, of a series of samples of crocidolite asbestos recently submitted to Messrs. Hale & Son, London, the "good, clean, short blue" was valued at £25 per ton, and "short to medium discoloured" fibre of the same grade at £22 per ton.

Mining and Dressing Operations.—While the greater part of the output of the Griqualand West fields was originally obtained by quarrying, at the present time quite a number of occurrences are being profitably worked by underground methods, the most important of these being the Koegas and Westerburg mines, belonging to the Cape Asbestos Company, and those at Naauwpoort, in the Hay District, and at Wonderwerk and Bretby, in the Kuruman District.

The mining of the asbestos, whether by open-cast or underground methods, is simple and comparatively inexpensive, though the following up of the thin and impersistent seams necessarily entails a good deal of dead work.

The fibre is readily separated from the enclosing shale and jasper by cobbing with light hammers, and this is the principal method of dressing resorted to. At Koegas a plant consisting of a pair of corrugated rolls arranged to run at different speeds and some sieving trommels has been installed, but all that is attempted is a rough cleaning of the short and inferior fibre.

As a rule everything under $\frac{3}{8}$ in. is discarded.

It is customary to separate the fibre into the following grades:—

D ... ... over 2 inches.
C ... ... from $1\frac{1}{4}$ to 2 inches.
B ... ... ,, $\frac{3}{4}$,, $1\frac{1}{4}$ inch.
A ... ... ,, $\frac{3}{8}$,, $\frac{3}{4}$,,
S ... ... $\frac{3}{8}$ of an inch and under.

Grade S is rarely recovered, and of grade D very little is produced.

The value of the different grades varies according to the length and quality of the fibre from £65 per ton to £5 per ton.

The declared average value of the asbestos produced on the Griqualand West fields in 1916 was £17. 11s. 5d., and, according to Frood, the fibre realizes an average of about £25 per ton landed in England.

The cleaned and graded fibre is packed into bags which are filled so as to contain about 112 lb.

The principal concern operating on the Griqualand West fields is the Cape Asbestos Company, which, in addition to being the most important producer, handles the greater part of the output of the smaller companies and syndicates. The company was formed in 1893 and owns 67,000 acres of proved asbestos-bearing ground. At the present time it produces about 100 tons of fibre per month, and buys approximately the same quantity. The company is also by far the largest manufacturer of blue asbestos goods. It has its own factories at Barking, England, Hamburg, and Turin, and a sister company, the Compagnie Francaise l'Amiante du Cap, has a factory in France.

The following list of the more important articles produced at the different factories of the company will give a good idea of the varied uses to which blue asbestos is put:—

Removable asbestos mattresses, which consist of an outer covering of blue asbestos cloth, stuffed with loose carded fibre and stitched through at intervals with asbestos twine to keep the fibre from shifting. They can be made of any size and thickness and are very extensively employed for covering marine and land boilers, steam turbines, the ends of steam cylinders, etc., being used in British, French, Italian, and German navies, on many railways, and in numerous power stations. All the locomotives of the South African Railways are fitted with them.
Blue asbestos rope for covering steam-pipes.
Removable pipe, valve, and angle valve coverings.
Removable flange coverings.
Blue asbestos cloth for covering hot-air pipes in iron works.
Blue asbestos felt.
Blue asbestos mill-board.
Blue asbestos curtains and brattice cloths for mines.
Blue asbestos rolled cloth packing.
Blue asbestos plaited yarn packing.
Blue asbestos wick or twisted yarn packing.
Lead and white metal asbestos cloth packing for high pressure packings.
Metallic asbestos cloth sheeting.
Metallic asbestos rolled cloth packing.
Blue asbestos metal packing.
Green rubbered asbestos sheeting.
Blue asbestos clothing, gloves, leggings.
Blue asbestos filter fibre.
Fine textured blue asbestos cloth for use in filter presses at chemical works, sugar refineries, etc. Blue asbestos filter fibre and cloths are extensively employed in British and French munition factories for filtering corrosive liquids.
Blue asbestos yarn, tape, and belting.
Blue asbestos tennis nets which are rot-proof.
Blue asbestos paper for lining floors and partitions and interlining roofs.
Blue asbestos paints.
Blue asbestos putties.
Blue asbestos non-conducting composition, which consists of a mixture of 15 parts of carded fibre and 85 parts of magnesia.
"Capyt" composition for electrical insulation.
Blue asbestos slates, tiles, sheathing, and cornices.

The Cape Asbestos Company has had a very hard fight to win for blue asbestos the recognition to which it is so richly entitled, and has only of recent years reached the dividend-earning stage. The capital of the company is £200,000. In 1916 a dividend of 2½ per cent., free of income tax, was paid on the ordinary, and an equivalent amount on the preference, shares. £5000 was put to reserve, and a sum of £5748 carried forward. The French Company was also for the first time in its history able to declare a dividend.

Other asbestos producers in Griqualand West are:—

The Carn Brea Asbestos Syndicate, Keikamspoort, Prieska.
The Crown Lands Asbestos Syndicate, Limited, Gathlose Native Reserve, and Bestwood, Kuruman.
Weingarten, S., Khosis, Kuruman, and other localities.
The Black Ridge Syndicate, Black Ridge, Hay.
The Elandsfontein Syndicate, Elandsfontein, Hay.
The Fram Asbestos Company, Vaalpoort, Rooidam, Rooipoort, Hay.
Gillanders and Campbell, Bretby, Hurley, Gamopedi Reserve Kuruman.
The Good Hope Asbestos Co., Stoffbokkies, Kliphuis, Prieska.
The Hay Asbestos Syndicate, Ltd., Leelijkstad, Hay.
The Khosis Asbestos Co., Ltd., Gathlose Native Reserve, Kuruman.
The Northern Asbestos Syndicate, Various, Barkly West.
The Stilverlaat Syndicate, Stilverlaat, Hay.

The asbestos production of Griqualand West amounted in 1915 to 2082.9 tons, valued at £33,166; in 1916 to 4227.8 tons, valued at £74,293; and during the first six months of 1917 to 1603 tons, the decrease being due to the difficulty in obtaining shipping space for the fibre.

The available supplies of blue asbestos are, as already stated, practically inexhaustible, and now that the merits of the mineral have become more generally recognized a very long and prosperous career may with confidence be predicted for the fields. The winning of the fibre, as we have seen, is very simple, and the asbestos mines appear to be very favourably situated as regards the supply and efficiency of the available native labour. The only adverse factor is the lack of transport facilities. The producing properties are seldom less than 100 miles from rail and the roads of the worst description.* In view of the growing importance of the industry the Department of Public Works might with advantage give some consideration to this matter.

Tiger's Eye or Cat's Eye.—At certain localities in Griqualand West, notably on the farm Naauwpoort in the District of Hay, the normal blue crocidolite asbestos has been converted by the oxidation of the iron and the infiltration of silica into a hard, brittle brownish yellow or yellowish brown substance of delicate fibrous structure and beautiful chatoyant lustre known as tiger's eye or cat's eye, and in the trade as crocidolite. It is used in jewellery and for ornamental purposes, affording the basis of a small industry. Enormous quantities of the mineral are said to be available on the farm Naauwpoort.†

Occurrences of Iron-Amphibole-Asbestos: Transvaal.—Lydenburg District.

An asbestos field of exceptional promise has been opened up during the past two years in the northern portion of the Lydenburg District, the asbestos occurring in bedded veins in ferruginous shales belonging

* *Cf.* Frood, *loc. cit.*
† *Cf.* Frood, *loc. cit.*, p. 77.

to the basal portion of the Pretoria series,* at a slightly lower horizon than the Griqualand West deposits.* The deposits have not as yet been accurately delimited, but appear to be of very great extent. The mineral was first discovered on the farm Penge No. 780, situated about 50 miles north of Lydenburg. It has since been proved to occur at the same horizon for a very considerable distance in a north-westerly direction, and is actually being worked in the valley of the Malips River, 35 miles north-west of Penge. To what extent the asbestos zone between Penge and the Malips River is workable is not known. The development of the field, having regard to its rather remote situation, has proceeded with remarkable rapidity, the output being already considerably in excess of that of Griqualand West, and it gives every assurance of becoming one of the most important asbestos-producing areas in the world.

At the present time operations are practically confined to Penge and the adjoining farm Streatham,† which are situated in the valley of the Olifants River, where the latter breaks through the Drakensberg. The area is mountainous and rugged and very inaccessible. The distance by road to Lydenburg, the nearest point on the railway, was originally 75 miles, but this has been reduced to 65 miles by the construction of a more direct road.

The asbestos is found in long irregular lenses up to 12 inches in thickness that overlap in such a manner as to form practically continuous layers extending over hundreds of yards. The lenses conform to the stratification of the enclosing rocks, which strike from north-west to south-east and dip at an angle of about 22 degrees to the south-east.

On Penge and Streatham there are three distinct asbestos zones that may conveniently be referred to as the upper, the middle, and the lower. The middle zone, which is separated from the upper by some 7 feet of ferruginous shale and from the lower by about 10 feet of the same rock, is by far the most important. It has been opened up over a distance of several miles, the combined thickness of the asbestos lenses of which it is made up ranging from 8 to 30 inches. At and near the surface the fibre, which is arranged more or less at right angles to the bedding, is of a dirty white colour—not unlike that of unwashed wool—rather harsh to the touch, inelastic, and of rather low tensile strength. At depth—the middle zone has been opened up on Penge to a depth of 350 feet on the incline—the mineral becomes cleaner in appearance and is gradually replaced at water level by more normal asbestos of very pale greenish colour, which, while still somewhat coarse and harsh to the touch, is capable of being teased out into thin, flexible, elastic fibres of great tensile strength. The length of

* *Cf.* Trevor, T. G., "Report [to the Government Mining Engineer—unpublished] on the Occurrence of Asbestos in the North Lydenburg District, exploited by the Egnep and Amosa Syndicates." A detailed description of this and the other asbestos fields in the Union will shortly be published by A. L. Hall, who is at work on a special geological survey memoir on the subject.

† The deposits on Penge are being worked by the Egnep Syndicate, which has a capital of £12,000 and holds a tribute over the farm, paying the owners, the Transvaal Consolidated Lands Company, a royalty of £1000 per annum and 10 per cent. of the value of the gross output. Operations on Streatham are being conducted by the Amosa (Asbestos Mines of South Africa) Syndicate who also hold contracts over Havercroft, Weltevreden, Kromellenboog, and Zamenloop. All of these farms belong to the Transvaal Estate and Development Company who receive a royalty of 20 per cent. of the value of the gross output. The syndicates are controlled by the same principals.

the fibre is anything up to 10 inches and rarely below 1 inch, the bulk of the material shipped at the present time ranging from 4 to 8 inches in length.

The dirty white surface stuff and the cleaner but still somewhat decomposed fibre by which it is succeeded at depth find a ready sale in the United States, where they are employed chiefly for lining the brake-bands of motor cars and in the manufacture of asbestos-covered metal.

The pale greenish fibre from the lower workings on Penge is at present being shipped in considerable quantities to Japan and the United States. It appears by reason of its length and great tensile strength to be admirably adapted for the manufacture of asbestos rope and textiles, and as no other field is capable of producing fibre of this length in such large quantities there can be no question, as previously stated, that the mineral is going to play a very important rôle in the asbestos manufacturing industry.

The inferior discoloured surface fibre is delivered f.o.r. Lydenburg at £7. 10s. per ton, and the best grade of undecomposed greenish fibre has been valued as high as £50 per ton on the London market.

The precise mineralogical composition of the fibre has not as yet been determined. It is undoubtedly amphibole asbestos, apparently monoclinic with a very small angle of extinction. It differs from tremolite and actinolite in containing up to 37 per cent. of ferrous oxide, from crocidolite in being apparently quite free from soda, and from all these minerals in containing up to 9.3 per cent. of alumina. An analysis of a sample from Penge by Professor Hahn showed:— SiO_2 49.72, FeO 37.80, Al_2O_3 5.725, CaO 1.65, MgO 3.77, Moisture 2.29. Another analysis gave SiO_2 49.10, FeO 43.86, MgO 6.14, CaO 4.6 and apparently no alumina.

The results of those analyses are very difficult to reconcile with one another, and further investigation is clearly needed.

Reserves.—There are proved reserves of several hundreds of thousands of tons of fibre on the farms Penge and Streatham alone, and the total tonnage available within the limits hitherto prospected must be enormous.

Mining and Treatment.—Owing to the remarkable regularity of the deposits, their comparatively great thickness and the fact that a good deal of pick-work is possible, conditions are very favourable to cheap mining on a large scale. So soon as adequate transport facilities are provided there should therefore be no difficulty in meeting any demand that may reasonably be expected to arise.

The dressing operations in connection with the preparation of the fibre for export are very simple. The material broken in the underground workings is on arrival at the surface roughly sorted and screened, the lumps of clean fibre being picked out and everything under $\frac{3}{4}$ inch discarded. What remains is sent to a cobbing shed, where the longer fibre is freed from the encasing shale by picannins armed with light sledge hammers, while the rock containing the shorter fibre is thrown aside, no attempt being made to recover by cobbing fibre under two inches in length.

The clean fibre is packed into sacks of 200 lb. and transported to Lydenburg Station by ox-wagon in loads of 4 tons; about 80 wagons being constantly employed on this work.

During September, 1917, 530 tons of fibre were conveyed to Lydenburg. Transport costs £2. 10s. per ton, and is thus a very considerable item in the working costs. The Government have been approached with a view to having a narrow-gauge railway built to the deposits, and the principals of the Egnep and Amosa syndicates have guaranteed the interest on such a line. Owing to the difficulty in procuring rails it appears doubtful, however, whether it will be possible to do anything in the matter until after the war.

5.—POSITION AND PROSPECTS OF THE SOUTH AFRICAN ASBESTOS MANUFACTURING INDUSTRY.

While small quantities of local fiberized asbestos have for years past been used in Rhodesia, on the Rand, and in Griqualand West and Natal for covering boilers and steam pipes, very little has up to the present been done in the way of utilizing South African asbestos in home manufactures.

There are as a matter of fact only two asbestos manufacturing establishments in the country, namely, that of Messrs. J. C. Chevers & Mansion, Capetown, who employ short asbestos fibre in the manufacture of a patent flooring composition, and that of the Iron, Concrete, and Asbestos Manufacturing Company, of Durban. The latter concern has a complete modern plant for the manufacture of asbestos-cement slates and tiles at Wentworth, just outside Durban. Zululand chrysotile asbestos was originally used, but at the present time medium-grade blue asbestos from the Kuruman District, costing £12 per ton, is being employed with very good results. The asbestos is first dried and then fiberized in an ordinary pug-mill, which has been found to answer just as well as an elaborate fiberizer orginally employed. The fiberized asbestos and Portland Cement in the proportion of 1:9.2 are then fed with water into a special mixer, where they are agitated for about 15 minutes. Should it be desired to make red tiles, a small quantity of powdered red iron oxide is added.

The mixture next passes into a feeding device and from this to a rather elaborate machine consisting of rolls and an endless travelling belt made of a special kind of felt. The asbestos-cement pulp is picked up by one of the rolls and spread in a thin layer on the belt and from this on to a steel collecting drum. When a sufficient thickness of the pulp has collected on the latter a bell rings and it is stripped off in large slabs. These are taken to an edge-trimming machine for squaring or cutting them up into tiles, and then to an hydraulic press, where they are pressed between thin steel plates.

The finished slabs or tiles, as the case may be, are cured by being kept in a drying-shed for two months, after which they are ready for use.

The asbestos-cement slates or slabs are made in the following sizes: 80 by 40 by $\frac{1}{4}$ inch, 80 by 40 by $\frac{3}{16}$ inch, 80 by 40 by $\frac{1}{2}$ inch, 40 by 40 by $\frac{3}{16}$ inch, 40 by 40 by $\frac{1}{4}$ inch, 6 feet by 3 feet by $\frac{1}{2}$ inch, 6 feet by 3 feet by $\frac{3}{16}$ inch. The $\frac{1}{2}$-inch slates are used for partitions, the $\frac{3}{16}$-inch slates for roofing purposes and the outside walls of portable buildings, and the $\frac{1}{4}$-inch slates for ceilings. Cove cornices corresponding to the various sizes and thicknesses are also made. The roofing and ceiling slates have been used

on a number of buildings in Durban and elsewhere and have given every satisfaction. They are also sent up-country in large numbers.

For the roofing tiles, which are made in different colours, there is, oddly enough, practically no demand.

Asbestos-cement slates and tiles appear to be eminently suited to South African climatic conditions, but there is unfortunately a good deal of prejudice against them among local architects and builders, owing to the fact that some of those imported into the country have been found to warp and crack rather badly in use. Properly seasoned asbestos slates and tiles, however, as may be judged by their popularity in Europe and America, are very durable and maintain their shape indefinitely. It is to be hoped therefore that the prejudice will disappear and that the enterprise of the Durban company will be rewarded and other plants for their manufacture established.

The manufacture of asbestos mattresses, of which large numbers are used on the railways and in steam-power plants, might also with advantage be undertaken locally, and the same applies to such articles as asbestos rope and piston-rod packing.

As regards the establishment of an export trade in manufactured asbestos goods, prospects are not very hopeful, the cost of skilled labour in South Africa being so high that it would hardly be possible to compete with manufacturing concerns in Europe and the United States. Since there is no likelihood of anything but a very small proportion of the asbestos produced in the country ever being used locally, it is thus to the creation of new markets abroad for our raw fibre that those interested in the development of the South African asbestos industry should devote their energies. In this connection it is especially desirable that the excellent qualities of the different varieties of fibre produced in the Union and Rhodesia should be made more widely known in the United States, which are by far the largest consumers of asbestos.

The central span of the new Quebec bridge was successfully placed in position on the 27th September. According to *Engineering* of the 28th September the operation extended over three days. The weight of the span is about 5000 tons and the height of lift 150 feet.

The Pretoria Portland Cement Company has recently completed the erection of its second kiln at the Slurry Works, Mafeking. It is estimated that from February of next year the works will be in a position to turn out upwards of 66,000 bags (188 lb.) per month.

Paper-making in the Union.

POSSIBILITIES AND PROSPECTS.

By Dr. C. F. Juritz, Agricultural Research Chemist.

The following report on the possibilities and prospects of paper manufacture in the Union has been submitted to the Hon. the Minister of Mines and Industries by Dr. Juritz, of Capetown:—

I have the honour to report that, as requested by you last August, I have made as full an investigation as circumstances permitted into the possibilities of establishing a paper-making industry within the Union of South Africa.

In order that such an industry may succeed anywhere five fundamental requirements must be satisfied. There must be—

1. A market for the finished product.
2. A sufficiency of raw material to ensure a constant supply for many years.
3. Abundance of pure water.
4. Proximity of fuel supplies.
5. Easy and cheap transport for the raw materials and chemicals to the mill and for distribution of the manufactured paper amongst the markets.

Hence success in paper-making is possible only where adequate demand, suitable fibre, pure water, efficient fuel, and cheap transport are satisfactorily combined within easy reach of each other.*

As far as can be judged the only part of the Union in which these conditions seem at all likely to combine in the immediate future is the Province of Natal, and in particular the vicinity of Maritzburg. In the next few pages I propose to set forth, as concisely as possible, my reasons for coming to this conclusion.

Market.

The most successful paper-making industry is, other things being equal, that which has the five fundamental requirements previously mentioned within easy reach of each other. Accordingly, when a market is sought, the first inquiries are for a *local* market. Now, South Africa has a small and rather scattered population whose wants in the line of stationery are varied, and, though the population may be small, one class of paper cannot be made to do for another. The consequence is that, except in one or two cases, the demand for any special class of paper is so insignificant that erection of a local mill

* It is also plain that a paper factory cannot prosper in a locality where the current rates of wages are high.

to deal with it would be out of the question. The two exceptions are news-paper and wrapping-paper. Of the former it would appear that, roughly taken, consignments to the extent of 5000 tons annually are imported into the Union, but it appears impossible to make the statement more definite, as both fine and common printing paper have been grouped together in the Customs Returns under the single head of "printing paper." Under this head the value of the imports for the last five years was as stated below:—

Year.	Value
1912	£193,201
1913	183,564
1914	197,338
1915	169,846
1916	391,144

With wrapping-paper may be included paper-bags, which are made of similar material; and of these two the values imported into the Union were as follows:—

Year.	Bags.	Wrapping-paper.	Total.
1912	£36,719	£71,297	£108,016
1913	40,222	75,770	115,992
1914	36,218	63,036	99,254
1915	41,806	82,076	123,882
1916	81,468	231,649	313,117

RAW MATERIALS.

Not to enter into too much detail at this stage it may be said that the raw material used for paper-making falls into three groups, namely, wood, grasses, and waste fibrous products. Of the first and last of these the quantities available in this country are by themselves quite inadequate for paper manufacture. When once a paper industry is in full operation they may perhaps be usefully brought in as adjuncts to other materials derived from a more abundant supply, but they will be altogether insufficient to *start* such an industry upon. The Chief Conservator of Forests is of opinion that the only class of tree within the Union that occurs in sufficient abundance to furnish an adequate supply of wood is the wattle, and unfortunately wattle-fibre seems to be too short for paper-making. Waste-paper and rags could be utilized to some extent, and perhaps to a considerable extent, if the collection of these materials were thoroughly organized, and transport to a readily accessible depot were inexpensive, but the condition of this source of supply is at present not such as to justify the establishment of a paper factory on so slender a basis.

Mention has, however, been made of a tree which has had a fair run of favour in the paper-making industry, although not dealt with by the same manufacturing process now adopted in the preparation of paper from wood. The allusion is to the Baobab tree. This used to be imported into England as a raw material for paper-making from the West Coast of Africa until displaced by the "mechanical" wood-pulp derived from Scandinavian and Canadian spruce and similar trees. The Baobab grows in the Western Transvaal and in the

Portuguese territory bordering on the Zambezi, but even in the latter area, where it seems to be more plentiful than in the former, it is, according to Mr. Sim, too sparse of occurrence, and too slow of growth, to yield the continuous supply over several years that one looks for in a raw material for paper-making. To use the Baobab at the rate at which paper would be needed would therefore be too much like living on one's capital.

One turns to the plants popularly known as "grasses"—a term loosely employed and including many other types of vegetation—as the only feasible source of raw material for paper.

There are large areas of grass-covered lands in various parts of the Union, but in many of these the third, fourth, and fifth fundamental requirements enumerated at the outset of this report are not concurrently fulfilled. In other cases the grass is either thin, short, and scanty, and therefore comparatively difficult and expensive to collect, or else not of a nature chemically suited for paper-making. The portion of the sub-continent where these objections seem to apply least, if at all, is the eastern coast belt, beginning in the Kentani District and extending northwards through the Transkei, Natal, and Zululand into the Portuguese territories. The quantities of these grasses available (broadly known as Dobo, and some of them also as Tambootie, Tambookie, or Tambuki) have been estimated, where they grow uniformly and to the exclusion of other vegetation, at about six tons per acre, and they vary from five or six feet in height to over sixteen. Some of them have been examined in the laboratories of the Imperial Institute and pronounced equal to esparto. Of these grasses the Chief Magistrate of the Native Territories said that after the requirements of the natives (for thatching) have been met there must still be about 100 square miles of grass-covered land available—land on which the grass is annually renewed and annualy wasted —destroyed by burning. If the Chief Magistrate's estimate of the available area is correct, one may expect from this territory alone, without reckoning in Natal, Zuluand, and the Portuguese country, an annual tonnage of grass aggregating tens of thousands.

Water Supply.

Not only is the eastern coast belt of the Union the more suitable for paper-making because of its abundance of grass, but it is there and there alone that numerous rivers, running parallel to each other, afford the abundant water supply without which no paper factory can be operated. Furthermore, some of the rivers offer the additional advantage of power in the shape of such waterfalls as those of Tsitsa, Albert, Howick (360 feet), and Edendale (120 feet). The flow of the Umzindusi River, immediately above the Edendale Falls, is stated to be (in October) 376 cubic feet per minute. Messrs Methven and Hall estimated that from a furrow taken out about 850 yards above the falls approximately forty horsepower could be obtained. In this connection it must, however, be remembered that the water supply for the Municipality of Maritzburg, which is now taken out above and below these falls, might be interfered with if such a project were to materialize.

It has been estimated that for every ton of finished paper from 50,000 to 70,000 gallons of water would be required, so that, taking

the lowest volume and also the lowest weekly quantity of paper, twenty-five tons, that it may be worth while to put up a mill for, the weekly amount of water needed would be 1,250,000 gallons, or over 200,000 gallons per day. Such a mill, however, would far from suffice to keep the Union in paper-bags and wrapping-paper.

Of course this water must be of good quality, and free from suspended matter, which would contaminate the paper-pulp and produce a dirty paper, unless a filtering plant were erected. The rivers then that may be considered seem to be the Umzimvubu and Umzimkulu in the Transkei, and the Umsindusi and Umgeni in Natal, any one of which would easily furnish the above-mentioned quantity of water.

Fuel.

Another article that must be within easy reach of a projected paper-mill is fuel; and when one says this the possible area at once becomes more restricted. In fact, one's view immediately becomes limited to the Province of Natal, for there alone is there sufficiency of fuel within easy reach. If we take the quantity of coal required at $2\frac{1}{2}$ tons per ton of paper turned out, the above small mill would need well over 3000 tons of coal per annum, and if we estimate the quantity of wrapping-paper consumed within the Union at 6000 tons per annum, no less than 15,000 tons of coal would be needed for its manufacture, and it is therefore essential that any paper industry that is contemplated should be erected as close as circumstances permit to one of the Natal coal mines.

Transport.

Considerations of transport impose a still further restriction of area. It is generally held that any other transport for the raw materials of paper-making than by means of water effectually kills all profit. As far as the finished article is concerned overland transport from the ports is at present and always has been inevitable, and accordingly no new feature would be introduced in this respect if the paper-mills were erected in any coastal district. For the raw materials and even for what is called "half stuff" or pulp, the considerations are different, but it is clear that, wherever a mill may be put up, there will have to be a certain amount of land transport of raw material. In order to meet the possibly increased expense that this would entail, the cost of distribution of the finished paper should be as low as possible. It becomes therefore imperative that a mill-site should not be sought elsewhere than at a centre whence distribution is as easy and cheap as possible.

Now throughout the whole area from Kentani to Beira, where the grasses already referred to grow, there is only one strip of country where such conditions hold, namely along the Durban-Maritzburg line of railway, preferably near the latter place because of the advantage offered by water-power, and in particular near the Howick Falls, where such power is at a maximum.

If either a pulping-mill or a more complete factory to turn out finished paper were erected near Howick, collecting depots could be established (1) in the vicinity of Port St. Johns for the Transkei,

whence oversea transport to Durban is easy; (2) near Somkele, which would serve the Zululand area and involve a 167-miles railway journey to Durban; (3) near Beira, whence water conveyance to Durban would be possible. In every case, however, there would still be necessary the carriage by rail from Durban to Howick—a distance of about 90 miles. It need hardly be said that here again it is essential for the prospects of profitable production that the cost of conveyance should be as low as possible.

From the point of view of distribution of the finished article also it is important that the distributing centre should be so situated that the bulk of its output may be conveyed over the longest distance by sea rather than by rail. Assuming that half the tonnage is required at Port Elizabeth, Natal, East London, and Capetown, and the other half in the Transvaal, it is obvious that if the mill were at Capetown or Port Elizabeth, half of its output would have to be conveyed about 1000 miles inland, and if it were at Johannesburg the other half would have to be railed to the ports. If, on the other hand Maritzburg were chosen as the centre, half of the output would need to be carried inland over no more than 400 miles, whereas sea conveyance would be available for the remaining half practically all the way.

Selection of a Site.

Perhaps the very first requisite for a paper-mill site is the presence, in an abundance that is likely to continue for many years, of suitable raw material. This condition appears to be fulfilled in the species of "grasses"—to comprise them all in this one popular designation for convenience sake—that are to be found extending from the Transkeian Territories in the south-east to the vicinity of Beira in the north-east of the sub-continent. Whether all the grasses that are to be found in that stretch of country are equally suitable—or are in some cases suitable at all for paper-making, is a point not yet thoroughly investigated, but, however that may be, no *other* extent of country in South Africa seems to offer so widespread an occurrence of species of *Andropogon*, which appears to promise better than any other Savannah grasses available.

The next requisite is abundance of water, and there again the same stretch of country, with its larger number of rivers than any other part of South Africa, seems to offer the highest hopes. One cannot say that all this water is good or available for paper factories, but, on the other hand, nowhere else in the country is a like supply of water obtainable.

(*a*) to carry the raw material to the mills, and
(*b*) to distribute manufactured paper to commercial centres.

The third important essential is cheapness of transport—

Water-borne transport is the ideal condition, some say the indispensable condition; but, be that as it may, the need of cheap transport at once restricts the possible site area. In view of this it seems that these possibilities become narrowed down to two pairs of localities: (1) either the Umzimvubu River, near Port St. Johns, or the Umtata, near the town of that name; and (2) either the vicinity

of Durban or the Umsindusi or Umgeni River, near Maritzburg. Of these two localities Natal would have the preferable claim if one accentuates its railway connection (for purposes of distributing the finished paper) with other chief centres of population. Now, if Natal is as well provided with suitable grasses as the territories to the north and to the south of her, that condition would seem to bring the problem near solution.

The position is that in the native territories of the Cape Province south of Natal we have the grasses loosely known as Tambuki or Dobo, while to the north of Natal there seems to be—in Zululand mainly—papyrus, and, still further north, in the Portuguese territory, more Tambuki grasses.

It seems to follow then, that if a paper mill is to be erected in Natal, it would have to draw its supplies of raw material from Beira to the north and from Port St. Johns to the south; on the other hand, if the mill were put up in Tembuland, it would largely lose touch with its hinterland, unless the railway line which now terminates at Umtata were extended to Kokstad and Franklin, so as to get closer to the Natal and Transvaal centres.

Professor Bews thinks quite sufficient grass would be obtainable in Natal to start the industry there. If he is right in this then it should be possible at a later stage to transport raw material thither by sea from Beira and Port St. Johns, and, taking all in all, I am inclined to favour this view. I have, however, referred more particularly to the grasses of Natal in my previous report on the grasses of the eastern coast belt.

THE PRESENT PROSPECT.

When all the above possibilities have been put in the best possible light it still remains to be said that conditions render the immediate establishment of a paper industry in South Africa out of the question. The first thing to be done in any case would be to erect a pulp-mill, and I believe it is hopeless to get any firm, either English or American, to specify for machinery of this class as long as munition work fills the whole horizon. Besides, in default of some practical outlook, the mere getting of a specification for a pulp-mill (let alone a mill for converting the pulp into finished paper) would avail nothing. If, however, the South African Newspaper Union, or any other body of men, would put down the requisite cash and take a practical step, there would be some object in procuring machinery. Moreover, even the manufacture of pulp would be aimless unless it could be converted into paper, either in South Africa or oversea: for such conversion in South Africa about ten times as much cash would be required as for the production of pulp, while to ship the pulp to England under war conditions is hardly practicable, and it must furthermore be remembered that a ton of pulp would be equivalent to about two tons of shipping. Under the circumstances no practical step can be taken in the erection of machinery until after the war, but in the meantime there is a great deal of scope for further chemical and technical investigation of raw materials and organization of other resources with a view to establishing an industry as soon as practicable after the close of the war.

The following is a list of the appendices to the foregoing report, which will be published in successive issues of the *Journal*:—

APPENDIX I.—HISTORICAL.

Introductory.
The Natal Industries Commission: 1905.
Paper-making possibilities in the Cape Peninsula: 1906.
Investigation by the Cape Government: 1907.
The Union Commerce and Industries Commission: 1910.
Papyrus and Tambuki grass: 1910-13.
Proposed mill at Pretoria.
Mr. Miller's scheme: 1914.
Zululand and Natal propositions: 1914.
Concession for cutting Papyrus: 1914.
Proposed exploitation of the Baobab tree.
Experiments at Port Elizabeth: 1916.
The grasses of the Transkei.
The question of railway rates: 1916.
A paper famine.
Investigation decided on.

APPENDIX II.—TECHNICAL.

Sources of materials for paper-making.
Principles of paper-making.
Relation of raw materials to class of paper.
Essentials for a mill site.
Essential characteristics of a paper fibre.
Classes and supplies of raw material.
Factors affecting the cost of paper-making.
Initial and running expenditure.
Class of labour needed.
Costs of transport.
Customs tariff.
Chemicals and water.
What South Africa could export.
News paper.
Effect of the war.
The manufacture of pulp.
Conversion of raw material into half-stuff.
Market value of half-stuff.
Cost of machinery.

APPENDIX III.—RAW MATERIALS IN SOUTH AFRICA.

Aristida.
Bamboo.
Banana.
Baobab.
Bowstring hemp.
Elephant grass.
Euphorbia spp.
Ficus spp.
Hedychium coronarium.
Maize.
Marram grass.
Matjesgoed.
Mauritius hemp.
Palmiet.
Papkuil.
Papyrus.
Prickly pear.
Rags.
Scilla rigidifolia.
Sisal hemp.
Spanish reed.
Straw.
Sugar-cane.
Waste paper.
Wilde honden grass.
Wood-pulp.
Grass from Boshof, Orange Free State.

APPENDIX IV.—THE INDUSTRIAL POSITION.

Australia's experience.
The Indian paper industry.
The Esparto industry in Spain.
Scandinavia and Canada.
The Natal proposition.
Experiments at Port Elizabeth.
Local demand.
Suggested centres for paper-making.

APPENDIX V.—BIBLIOGRAPHY.

The Labour Situation in October.

The following notes have been supplied by the Department of White Labour:—

Employment Statistics.

The demand for labour during October, as reflected in the returns from the Labour Exchanges, shows little alteration compared with the previous month. Applications for employment denote an increase of 202, from employers an increase of 54, whilst the number of persons placed in work increased by 96. Against these figures must be placed the returns from the Bloemfontein office, which appear for the first time, and amount to 136, 60, and 60 respectively. The work of the Labour Exchanges has shown a steady increase since the recent reorganization, and as the existence and public benefit of the offices become more widely known the results may be expected to improve.

In the Cape Peninsula there would appear to have been less regularity of employment in some trades than during September, owing, no doubt, to the uncertainty of obtaining adequate supplies of raw material. In some instances contracts have been refused for this reason. Work on electrical installations has considerably decreased consequent on a shortage of material. On the whole, however, work in most branches of trade continued active. Wages in the skilled trades show a continued upward tendency.

Reports from the Transvaal and Natal Provinces show that little or no difficulty was experienced by skilled workmen in finding employment.

Much perturbation was evinced in the ranks of certain classes of unskilled labourers owing to statements in the Press that the state of the finances of the Transvaal Provincial Administration portended the abolition of the vote for relief works.

Industrial Unrest.

A strike in the tailoring trade at Capetown was declared on the 22nd October. At first some 200 employees in two establishments were effected. The objects were stated to be a "living wage" in accordance with a schedule submitted to the employers, a 50-hour week, special rates for overtime, payment for legal public holidays, and the indenturing of apprentices. On the 30th October approximately 800 employees of ten additional firms also ceased work.

At a conference of both parties held on the 31st October an agreement was arrived at which provided for an increase of wages, no victimization, and the increases to operate from the date on which the employees resumed work.

A number of disputes of a minor nature occurred on the Witwatersrand, but in only two cases did an actual stoppage of work occur. In one case the fitters and turners at an engineering establishment ceased work for one day. The dispute was of a purely internal nature and was amicably settled. In the other instance the underground mechanics on one of the mines ceased work for two days, contending they were not being paid in terms of a recent agreement. It was pointed out the agreement did not come into operation until 1st November. Work was then resumed.

In other instances the disputes were settled without cessation of work.

The arguments for Conciliation Boards received support at Randfontein, where certain contentious matter became the subject of a round-table conference between men and employers under the chairmanship of the Resident Magistrate. An agreement was arrived at.

In the Natal Province, strikes in the printing trades at Durban and Pietermaritzburg were settled by the concession of increased wages.

The strike at a Durban refrigerator engineering works came to an end early in the month.

DISTRICT ADVISORY BOARDS.

In order to obtain a better idea of the general labour conditions, to foster the employment of white instead of coloured labour, and to obtain proposals and recommendations with regard to labour generally, Labour Advisory Boards are to be established in each Magisterial District throughout the Union. A start will be made with the Transvaal Province, and steps to this end have been taken. The Labour Department invites the co-operation of able and influential people towards the attainment of the objects aimed at.

APPRENTICESHIP.

A conference arranged by the Governing Body of the Pretoria Trades School and Polytechnic was held in the Municipal Council Chamber on the 30th October. After discussion, resolutions were passed embodying the following opinions:—

(1) That the conditions of apprenticeship in each trade should be laid down.
(2) That the best apprenticeship comprises a period in a Trades School followed by a term in a commercial shop.
(3) That apprenticeship may be completed without attendance at a Trades School, but in such cases the period spent in the commercial shop should be longer.
(4) That the wages of apprentices should be a certain percentage of a fully qualified artisan, increasing periodically.
(5) That the standard of entry to a Trades School should be Standard VI.
(6) That the period of apprenticeship should be five years.
(7) That no indentures be signed until the age of 16 years is reached.
(8) That no lad be accepted after the age of 18 years.
(9) That the Trades School course be two years, to count as one in the workshop.
(10) That the principle that apprentices be allowed time during working hours without deduction of pay for continuation classes be adopted.

It was further resolved that it is desirable that legislation be introduced on the above lines. Some doubt was expressed as to whether a period of five years is sufficient for an apprentice in the printing trades.

The accompanying table indicates the number of applications received for employment and from employers, together with the number of persons for whom employment was found during the month under review.

THE LABOUR MARKET.

The following Statement shows the number of applications for employment and the number of applications from employers of labour in the several centres and in respect of the principal occupations, received by the Superintendent of White Labour during the month of October, 1917, together with the number of persons for whom employment was found during that month :—

Occupations.	Applications for Employment.						Applications from Employers of Labour.						Employment found.					
	Johannesburg.	Pretoria.	Capetown	Durban.	Bloemfontein.	Totals.	Johannesburg.	Pretoria.	Capetown.	Durban.	Bloemfontein.	Totals.	Johannesburg	Pretoria.	Capetown.	Durban.	Bloemfontein.	Totals.
1. Mining occupations	38	—	1	—	2	41	5	—	—	—	—	5	5	—	—	—	—	5
2. Engineering trades	44	8	25	36	1	114	15	1	18	13	—	47	15	1	4	13	—	33
3. Building trades	53	20	25	18	13	129	29	8	24	9	3	73	29	8	15	9	3	64
4. Printing and Publishing trades ...	1	4	2	2	1	10	—	—	12	—	—	12	—	—	1	—	—	1
5. Clerical and semi-professional occupations	40	14	14	36	4	108	12	7	1	14	1	35	12	7	3	13	1	36
6. Food industries	7	1	1	1	3	13	—	—	—	—	—	—	—	—	—	—	—	—
7. Clothing and Textile industries ...	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
8. Woodworking industries	1	2	1	3	—	7	—	1	12	—	—	13	—	1	1	—	—	2
9. Other industries	5	3	4	—	—	12	4	—	15	—	—	19	4	—	—	—	—	4
10. Farm and Garden occupations ...	39	11	6	3	18	77	9	13	15	—	1	38	6	9	32	—	1	48
11. Domestic occupations...	10	—	7	6	—	23	6	—	4	5	—	15	6	—	2	2	—	10
12. Overseers, Warders, Attendants, Messengers, etc.	16	19	13	3	13	64	6	5	1	10	6	28	6	5	3	—	6	20
13. Handymen and Unskilled labourers...	72	82	172	58	81	465	23	25	10	29	49	136	23	25	12	20	49	129
14. Juveniles	88	—	32	—	—	120	40	—	22	—	—	62	30	—	31	—	—	51
15. Females...	95	46	12	—	—	153	83	30	9	—	—	122	79	13	8	—	—	100
TOTALS...	509	211	315	166	136	1337	232	90	143	80	60	605	215	69	102	57	60	503
TOTALS FOR PREVIOUS MONTH...	552	210	239	154	—	1135	138	110	230	73	—	551	207	85	66	49	—	407

Mining Labour Statistics.

THE following statements have been prepared from returns compiled by the Government Mining Engineer:—

I.—Summary of Returns of Labour employed by Mining Companies and Companies' Contractors (including lime, flint, and gypsum works) during the month of September, 1917:—

Nature of Establishment.	White. No. in Service.	Coloured. No. in Service.	Total. No. in Service.
Gold Mining *	23,077	185,562	208,639
Diamond Mining	3,072	18,379	21,451
Diamond Alluvial, Estate, and River Digging ...	3,325	16,556	19,881
Coal Mining	1,451	29,459	30,910
Copper Mining	330	3,097	3,427
Tin Mining	226	2,762	2,988
Other Base Mineral Mining	114	3,820	3,934
Works (Lime, Flint, and Gypsum)	78	1,263	1,341
TOTALS	31,673	260,898	292,571

* Including metallurgical and tailings works.

II.—Summary of Accidents to Employees of Mining Companies, Miscellaneous Works, and Diggings during the month of September, 1917:—

Nature of Establishment.	No. of Separate Accidents.	Killed.		Injured.	
		White.	Coloured.	White.	Coloured.
Gold Mining	147	2	26	16	118
Diamond Mining	15	—	1	—	14
Coal Mining	27	—	5	2	21
Base Mineral Mining	6	—	1	1	5
Miscellaneous Works and River Diggings	7	1	1	4	1
TOTALS	202	3	34	23	159

The Union's Black List.

THE following is a return of articles imported during the nine months ended September, 1917, which it is considered are capable of being produced within the Union.

The corresponding figures for 1913 are introduced for purpose of comparison.

ARTICLE.	1917.		1913.	
	Quantity.	Value.	Quantity.	Value.
		£		£
ARTICLES OF FOOD AND DRINK—				
Chicory.....lb.	197,934	6,446	1,936,288	17,409
Corn, Grain, and Meal—				
Barley.....lb.	100	2	54,427	376
Beans and Peas.....lb.	4,395,950	22,181	12,793,937	63,567
Malt.....lb.	4,328,516	51,457	8,264,922	62,792
Wheat.....lb.	141,084,085	719,230	230,807,709	768,169
Flour, Wheaten.....lb.	52,014,633	386,149	137,766,156	601,263
Fruit—				
Dried.....lb.	1,067,986	34,737	1,713,646	28,965
Bottled and Tinned.....lb.	70,162	2,310	869,173	15,925
Sugar and Sugar Products....lb.	16,789,791	120,774	46,794,408	308,186
Tea.....lb.	5,237,840	217,347	4,850,091	224,428
Vegetables—				
Onions.....lb.	3,156	19	615,782	1,523
Potatoes.....lb.	111,648	746	8,748,255	28,085
Other kinds, fresh.....	—	—	—	9
Preserved of all kinds.....lb.	324,158	7,773	2,478,601	35,381
Dairy Products—				
Butter.....lb.	24,747	1,996	3,488,492	168,006
Butter substitutes.....lb.	181,220	6,497	884,436	21,029
Cheese.....lb.	292,705	17,386	4,275,135	128,590
Milk.....lb.	8,295,370	259,481	16,594,432	338,586
General Farm Produce—				
Eggs, fresh.....*	120	9	21,211,434	77,362
Hams and Bacon.....lb.	399,975	25,635	4,522,788	191,448
Lard.....lb.	507,197	23,182	2,482,043	57,731
Meats, frozen—				
Beef.....lb.	—	—	7,775,180	72,119
Mutton.....lb.	—	—	2,126,803	20,075
Pork.....lb.	—	—	3,920	85
Meats, salted and cured.....lb.	93,080	3,068	127,159	3,143
Meats, preserved.....lb.	1,160,235	63,829	3,003,474	110,803
MISCELLANEOUS ARTICLES OF FOOD AND DRINK—				
Aerated Waters.....	—	3,995	—	9,905
Biscuits.....lb.	218,710	5,953	1,748,592	46,041
Cakes.....lb.	18,450	1,071	125,426	5,139
Confectionery.....lb.	1,221,517	70,309	4,865,409	197,763
Jams and Jellies.....lb.	601,965	12,773	1,768,696	32,428
Pickles and Sauces.....lb.	547,694	22,664	1,078,867	34,104
Salt, common and table.....lb.	3,522,985	7,457	17,473,533	12,505
Vinegar.....gls.	34,483	5,456	85,879	7,946
TOTAL, FOOD AND DRINK..	—	2,099,932	—	3,690,886

* In the 1913 returns the *number* of eggs imported is shown; the 1917 figures refer to *weight* (in lb.).

ARTICLE.	1917.		1913	
	Quantity.	Value.	Quantity.	Value.
MISCELLANEOUS ARTICLES NOT FOOD AND DRINK—		£		£
Acetic Acid.....gls.	322	329	393	145
Candles.....lb.	19,924	761	496,207	7,397
Cement.....lb.	18,363,300	21,102	146,237,448	103,372
Coke and Patent Fuel (tons of 2000 lb.)	3,905	7,210	23,567	26,937
Earthenware, including Bricks..	—	110,403	—	119,429
Furniture.....	—	228,381	—	483,930
Leather—				
Saddlery and Harness.....	—	7,310	—	52,198
Manufactured N.O.D.....	—	39,398	—	87,454
Unmanufactured.....lb.	758,036	101,397	2,110,391	163,031
Oils—				
Castor.....gls.	75,093	22,176	84,693	14,896
Linseed.....gls.	156,459	35,663	325,933	34,238
Cordage and Rope.....cwt.	16,669	60,206	19,034	40,930
Soap, common.....lb.	1,426,286	19,618	5,344,089	44,500
Stones, Marble, and Slates for roofing	—	9,067	—	24,976
Tobacco—				
Unmanufactured.....lb.	281,718	13,176	663,704	34,505
Cigars.....lb.	44,064	28,390	76,464	34,710
Cigarettes.....lb.	63,352	25,869	243,519	65,357
Manufactured.....lb.	56,771	5,052	39,000	4,159
Vehicles—				
Carts, Carriages, Wagons, and parts, not motor	—	6,983	—	30,601
TOTAL MISCELLANEOUS AS ABOVE	—	742,491	—	1,372,765
GRAND TOTAL.....	—	2,842,423	—	5,063,651

Output of the Mines.

SUMMARY OF THE RETURNS FOR SEPTEMBER, 1917.

THE following is a statement, compiled from returns prepared by the Government Mining Engineer, of the production during the month of September of the various metals, minerals, and precious stones specified, together with the total production from the 1st January, 1917:—

Metal, Mineral, or Precious Stone.	September, 1917.		Nine months ended September, 1917.	
	Quantity.	Value.	Quantity.	Value.
Gold.....(fine ozs.)	737,576·534	£3,133,026	6,820,614·985	£28,972,128
Silver.....(fine ozs.)	76,134·148	11,172	714,033·140	89,286
Diamonds.....(carats)	252,410·35	683,618	2,175,469·31	5,771,205
Coal.....(tons)	869,499	277,258	7,792,149	2,454,515
*Copper.....(tons)	139·000	6,963	12,121·009	679,492
*Tin.....(tons)	179·932	23,298	2,177·279	292,391
*Antimony.....(tons)	11·000	275	491·550	9,760
Asbestos.....(tons)	784·977	9,498	4,769·383	68,419
Corundum.....(tons)	246·961	1,572	1,534·420	7,882
Graphite.....(tons)	3·787	111	61·875	1,819
Iron oxide.....(tons)	30·600	75	98·400	255
Iron pyrite.....(tons)	349·500	502	1,797·500	2,754
Kaolin.....(tons)	—	—	28·000	19
*Lead.....(tons)	50·000	770	270·123	3,761
Magnesite.....(tons)	55·000	144	495·000	1,299
Manganese.....(tons)	—	—	123·500	641
Mica.....(tons)	1·256	243	1·752	370
*Nickel.....(tons)	—	—	—	—
Scheelite.....(tons)	0·288	50	6·739	1,187
Soda (crude).....(tons)	540·000	3,474	4,595·750	23,836
Talc.....(tons)	—	—	37·172	113
*Zinc.....(tons)	—	—	—	—
Lime.....(tons)	7,352·000	10,852	67,619·000	99,927
Flint.....(tons)	13·000	97	151·000	956
Gypsum.....(tons)	—	—	979·000	2,858
Totals.....	—	£4,162,998	—	£38,484,873

* The value given is the value of metallic content.

The gold output for October has been declared at 751,290 ounces (value £3,191,279).

3 0112 073188291

Telegrams : "Excel," Zuider Paarl.

H. JONES & CO.

(S.A.), LTD.

Fruit Buyers,
Jam Manufacturers,
and
Fruit Preservers.

PROPRIETORS OF—

IXL,
All Gold,
and
Silver Leaf Brands.

FACTORY AND OFFICES—

Opposite Paarl Railway Station,
Cape Province.

12—2-3-4-5-6 7